Chapter 3. Surface Water Monitoring and Assessment

3.1 Monitoring Program - General

DOW uses NHD 1:24,000 scale maps for monitoring, planning, and assessment. As noted in Chapter 2, there are more than 90,000 miles of streams in the commonwealth at this resolution. Of particular interest in this IR for new 305(b) assessments are two BMUs, the Kentucky and Salt-Licking (the latter is two river basins combined to form one BMU), which were the focus of monitoring in 2003 and 2004, respectively. Table 3.1-1 provides stream miles for those two BMUs by river basin.

Table 3.1-1. Total stream miles (NHD 1:24,000 scale) of respective river basins and BMUs in the Kentucky and Salt - Licking BMU.

Kentucky River Basin (BMU)	16,071
Salt - Licking BMU	22,322
Salt River Basin	9,621
Licking River Basin (incl. minor Ohio River Tributary HUCs)	12,701

For this report, monitoring occurred in 13 of the state's 42 eight-digit HUCs (hydrologic unit codes) established by the U.S. Geological Survey (Figure 3.1-1). In the Salt-Licking BMU, 562 stream segments were assessed on 245 streams (Figure 3.1-2), and 373 stream segments were assessed on 311 streams in the Kentucky River BMU (Figure 3.1-3). The Ohio River minor tributaries associated with the Licking River Basin (Ohio River Subregional Boundary, USGS) had a total of 53 segments and 43 streams from those two HUCs. Most of these assessments stemmed from intensive multi-agency watershed monitoring in 2003 and 2004. However, some data more than five years old were still considered valid for this reporting period.

3.1.1 Ambient (Long-Term) Monitoring Network

Water Quality. The KDOW's statewide ambient water quality monitoring network has 70 fixed stations (Table 3.1.1-1 and Figure 3.1.1-1). These ambient stations are located in the downstream and mid-unit reaches of USGS 8-digit hydrologic (cataloging) units, upstream of major reservoirs and in the downstream reaches of major tributaries. The Kentucky River BMU has 15 ambient stations and the Salt-Licking

BMU has 14 ambient water quality stations (Table 3.1.1-2). The ambient stations of a watershed management unit are sampled monthly during the year the unit is in the monitoring phase of the watershed cycle. During the other four years of the watershed cycle, sampling frequency is reduced to bimonthly to devote more monitoring and laboratory resources to the rotating watershed water quality network (described later). Field measurements are taken for pH, dissolved oxygen, specific conductance and temperature, and samples are analyzed for nutrients, metals and also pesticides and herbicides if the streams are in predominantly agricultural areas. The purpose of the ambient water quality sampling is to assess long-term conditions and trends on rivers and the larger streams of the state. In addition to DOW's network, long-term stations are maintained by ORSANCO on the lower Licking, lower Big Sandy, lower Green, lower Tennessee and lower Cumberland rivers and by the USGS on the lower Tennessee River. Figures 3.1.1-2, 3.1.1-3 and 3.1.1-4 give general locations of ambient monitored stations (including associated biomonitored stations) in the Kentucky River BMU and Salt and Licking rivers basins, respectively.

Sediment Quality. Sediment quality is determined at the ambient stations during the year in which monitoring occurs in a watershed management unit. At this time, sediment data supplement other data types; the data are not used directly in assessments of use support.

Biology. Fish, macroinvertebrate and algae data from the ambient stations provide long-term and trend information on mainstem rivers and many major tributaries. These stations will be revisited every five years. Most of the ambient biological stations are located on streams that also have water quality monitoring.

Fish Tissue. Fish tissue samples were obtained from 20 sites in the Kentucky River BMU and six sites in the Salt-Licking BMU; however, 21 other sites were monitored throughout Kentucky related to advisories. Tissue is analyzed for metals, including mercury, PCBs, chlordane, pesticides and herbicides. Results are used to determine if there are potential problems with contaminants in fish tissue that require further sampling. If results are not elevated, no further fish tissue sampling is conducted.

Table 3.1.1-1. Statewide primary water quality stations, with Kentucky River and Salt-Licking rivers BMUs highlighted in bold type.

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Drainage (mi^2)	Station Type
Big Sandy								
[a]Tug Fork	PRI002	05070201	35.1	at Kermit, WV	37.8379	-82.40970	1280	hydrologic unit index site
[a]Tug Fork	PRI003	05070201	77.7	at Freeburn	37.56615	-82.14358	271	mid-hydrologic unit index site
[a]Levisa Fork	PRI006	05070202	115.0	nr Pikeville	37.46435	-82.52589	1232	hydrologic unit index site
[a]Levisa Fork	PRI064	05070203	29.6	nr Louisa	38.1160	-82.6002	2326	hydrologic unit index site
[a]Levisa Fork	PRI094	05070203	75.0	at Auxier	37.72905	-82.75436	1726	mid-hydrologic unit index site
[a]Beaver Creek	PRI095	05070203	95.0	at Allen	37.60280	-82.72754	240	major tributary
[a]Johns Creek	PRI096	05070203	26.6	at McCombs	37.6553	-82.5870	168	inflow to Dewey Res. major tributary
Little Sandy								
[a]Little Sandy River	PRI049	05090104	13.2	at Argillite	38.49053	-82.83404	522	hydrologic unit index site
Tygarts Creek								
[a]Tygarts Creek	PRI048	05090103	23.5	nr Lynn	38.5997	-82.9528	242	hydrologic unit index site
Cumberland River								
Cumberland River	PRI086	05130101	661.0	at Calvin	36.72233	-83.62554	770	mid-hydrologic unit index site
Cumberland River	PRI009	05130101	563.0	at Cumberland Falls	36.83558	-84.34015	1977	hydrologic unit index site
Clear Fork	PRI087	05130101	0.9	nr Williamsburg	36.7259	-84.1424	370	major tributary
[a]Rockcastle River	PRI010	05130102	24.7	at Billows	37.17137	-84.29673	604	hydrologic unit index site
[a]Horse Lick Creek	PRI051	05130102	0.1	nr Lamero	37.3204	-84.1387	62	special interest watershed
Cumberland River	PRI007	05130103	423.0	nr Burkesville	36.68881	-85.56670	6053	hydrologic unit index site
Buck Creek	PRI088	05130103	12.3	nr Dykes	37.0601	-84.4264	294	major tributary
[a]S. Fk. Cumberland R.	PRI008	05130104	44.8	at Blue Heron	36.6703	-84.5492	954	hydrologic unit index site
[a]Little River	PRI043	05130205	24.4	nr Cadiz	36.84104	-87.77731	269	major tributary
Red River	PRI069	05130205	49	nr Keysburg	36.64065	-86.97961	509	hydrologic unit index site

Table 3.1.1-1 (cont.). Statewide primary water quality stations, with Kentucky River and Salt-Licking rivers BMUs highlighted in bold type.

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Drainage (mi^2)	Station Type
Kentucky River								
[a]**Eagle Creek**	PRI022	05100205	21.5	at Glenco	38.7061	-84.8254	437	hydrologic unit index site
Kentucky River	PRI024	05100205	64.8	at Frankfort	38.2129	-84.8721	5412	hydrologic unit index site
Kentucky River	PRI066	05100205	30.5	nr Lockport	38.4450	-84.9569	6180	hydrologic unit index site
Kentucky River	PRI067	05100205	119.0	at High Bridge	37.8201	-84.7051	5036	hydrologic unit index site
[a]**Elkhorn Creek**	PRI098	05100205	10.3	nr Peaks Mill	38.2686	-84.81429	473	major tributary
[a]**Dix River**	PRI045	05100205	34.7	nr Danville	37.64176	-84.66113	318	hydrologic unit index site
Silver Creek	PRI099	05100205	5.9	nr Ruthton	37.73251	-84.43674	100	major tributary
Kentucky River	PRI058	05100204		nr Trapp	37.84675	-84.08182	3236	hydrologic unit index site
Red River	PRI046	05100204	21.6	Clay City	37.86468	-83.93316	362	hydrologic unit index site
N. Fork Kentucky River	PRI031	05100201	49.7	Jackson	37.55127	-83.38464	1101	hydrologic unit index site
Troublesome Creek	PRI090	05100201	7.2	nr Clayhole	37.46722	-83.27936	187	major tributary
[a]**Middle Fk. Kentucky R.**	PRI032	05100202	8.4	nr Tallega	37.55505	-83.59373	537	hydrologic unit index site
[a]**South Fork Kentucky R.**	PRI033	05100203	12.1	at Booneville	37.47513	-83.67082	722	hydrologic unit index site
Red Bird River	PRI091	05100203		nr Oneida	37.23656	-83.61150	190	major tributary
Goose Creek	PRI092	05100203	3.4	nr Oneida	37.23280	-83.69103	250	major tributary
Licking River								
Licking River	PRI062	05100101	226	at West Liberty	37.91470	-83.26169	335	inflow to Cave Run Reservoir
[a]**Slate Creek**	PRI093	05100101	10.0	nr Owingsville	38.1415	-83.7285	230	major tributary
[a]**Licking River**	PRI061	05100101	78.2	at Claysville	38.52058	-84.18310	1993	mid-hydrologic unit index site
[a]**N. Fork Licking River**	PRI060	05100101	6.9	nr Milford	38.58123	-84.16566	290	major tributary
[a]**S. Fork Licking River**	PRI059	05100102	11.7	at Morgan	38.6033	-84.4008	839	hydrologic unit index site
[a]**Hinkston Creek**	PRI102	05100102	0.2	at Ruddles Mill	38.30471	-84.23778	260	major tributary
[a]**Stoner Creek**	PRI101	05100102	0.6	nr Ruddles Mill	38.3029	-84.2497	284	major tributary
[b]**Licking River**	PRI111	05100101		at Butler	38.7898	-84.3674		hydrologic unit index site

Table 3.1.1-1 (cont.). Statewide primary water quality stations, with Kentucky River and Salt-Licking rivers BMUs highlighted in bold type.

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Drainage (mi^2)	Station Type
Licking River								
Licking River	PRI062	05100101	226	at West Liberty	37.91470	-83.26169	335	inflow to Cave Run Reservoir
Ohio River Tributary								
[a]Kinniconick Creek	PRI063	05090201	10.4	nr Tannery	38.57458	-83.18811	230	major tributary
Salt River								
[a]Salt River	PRI029	05140102	22.9	at Shepherdsville	37.98524	-85.71720	1197	hydrologic unit index site
[a]Salt River	PRI052	05140102	82.5	at Glensboro	38.00231	-85.06028	172	major reservoir inflow
Brashears Creek	PRI105	05140102	1.2	at Taylorsville	38.03040	-85.35154	262	major tributary
[a]Floyds Fork	PRI100	05140102	7.4	nr Shepherdsville	38.03447	-85.65936	259	major tributary
[a]Rolling Fork	PRI057	05140103	12.3	nr Lebanon Jct.	37.82267	-85.74787	1375	hydrologic unit index site
[a]Beech Fork	PRI041	05140103	48.0	nr Maud	37.83266	-85.29610	436	major tributary
Green River								
[a]Green River	PRI018	05110001	226.0	at Munfordville	37.2687	-85.8853	1673	hydrologic unit index site
Green River	PRI076	05110001	334.0	at Neatsville	37.1919	-85.1303	339	major reservoir inflow
[a]Nolin River	PRI021	05110001	80.9	at White Mills	37.55530	-86.03177	357	major reservoir inflow-tributary
[a]Russell Creek	PRI077	05110001	10.0	nr Bramlett	37.1678	-85.4702	289	major tributary
Little Barren River	PRI078	05110001	6.3	nr Monroe	37.2264	-85.6776	256	major tributary
Bear Creek	PRI075	05110001	11.8	nr Huff	37.2488	-86.3612	159	major tributary
Barren River	PRI072	05110002	1.0	nr Woodbury	37.17069	-86.62052	1968	hydrologic unit index site
Drakes Creek	PRI074	05110002	8.0	nr Bowling Green	36.39212	-86.39212	502	major tributary
Green River	PRI055	05110003	72.0	at Livermore	37.47832	-87.12694	6431	hydrologic unit index site
Mud River	PRI056	05110003	17.4	nr Gus	37.1233	-86.9006	268	major tributary
Green River	PRI103	05110003	150.0	nr Woodbury	37.18174	-86.61507	3140	hydrologic unit index site
Rough River	PRI014	05110004	62.5	nr Dundee	37.54713	-86.72108	757	mid-hydrologic unit index site
Rough River	PRI054	05110004	1.0	nr Livermore	37.4993	-87.0653	1068	hydrologic unit index site
[b]Panther Creek	PRI113	05110005		nr West Louisville	37.72515	-87.31462		major tributary
Pond River	PRI012	05110006	12.4	nr Sacramento	37.44198	-87.35303	523	hydrologic unit index site

Table 3.1.1-1 (cont.). Statewide primary water quality stations, with Kentucky River and Salt-Licking rivers BMUs highlighted in bold type.

River Basin & Stream	Station	HUC	Mile-point	Location	Latitude (dd)	Longitude (dd)	Drainage (mi^2)	Station Type
Ohio River Tributary								
[b]Highland Creek	PRI110	05140102		nr Smith Mill	37.7569	-87.7950		major tributary
Tradewater River								
[a, b]Tradewater River	PRI112	05140205		nr Piney	37.39896	-87.90470		hydrologic unit index site
Tennessee River								
Clarks River	PRI106	06040006		nr Sharpe	36.9612	-88.4928		hydrologic unit index site
W. Fork Clarks River	PRI107	06040006		nr Symsonia	36.9324	-88.5439		major tributary
Mississippi River								
[a, b]Bayou de Chien	PRI109	08010201		nr Cayce	36.6154	-89.0302		major tributary
[a]Mayfield Creek	PRI042	08010201		nr Magee Springs	36.9299	-88.9430		major tributary

[a]Long-term ambient water quality stations that are also long-term ambient biological monitoring stations
[b]Stations created since 2004 (these were changes necessary for sampler safety issues)

Figure 3.1.1-1. Fixed primary (long-term) ambient surface water quality network.

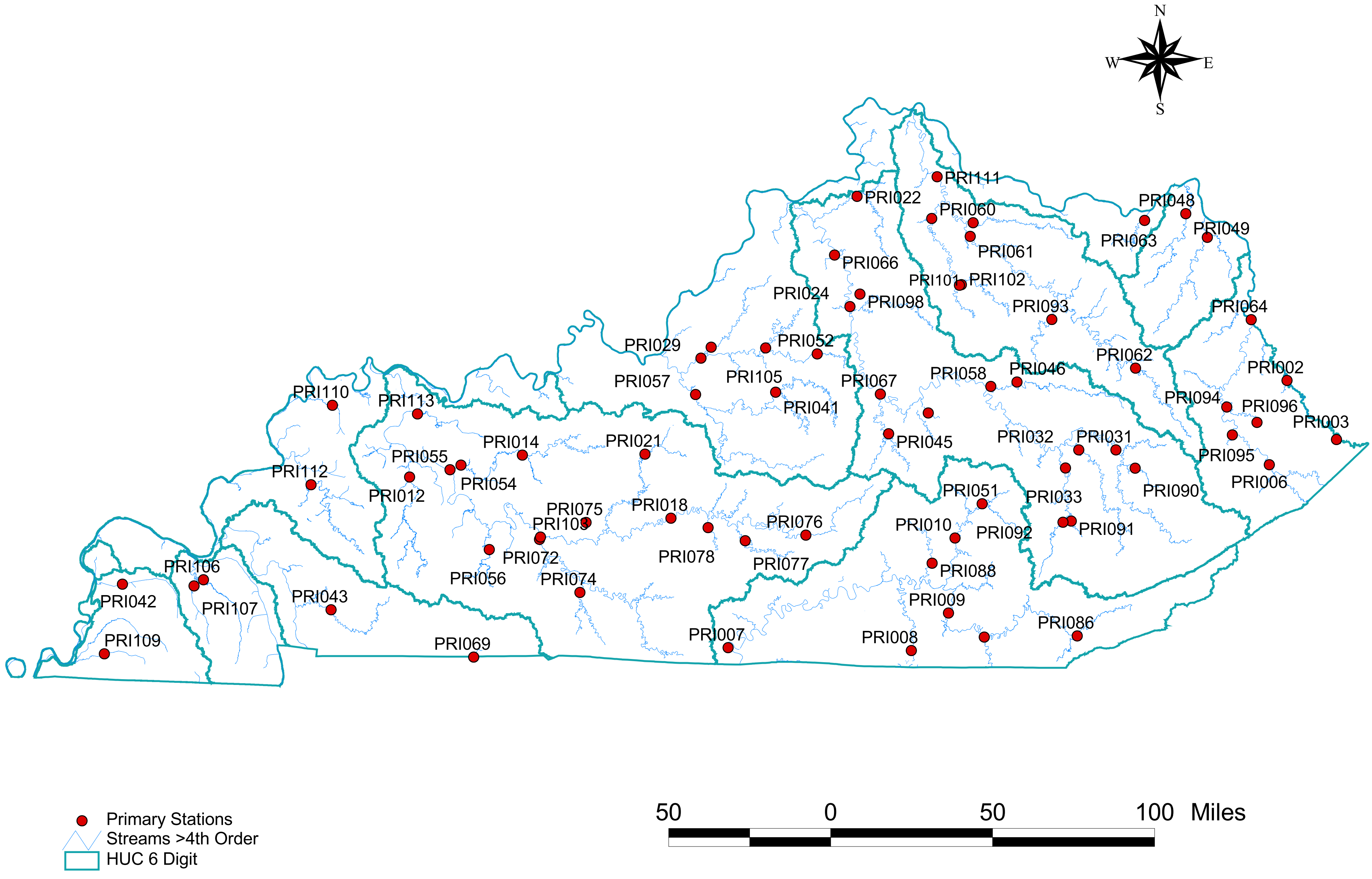


Figure 3.1.1-2. Targeted biological and ambient water quality monitoring in Kentucky River Basin Management Unit.

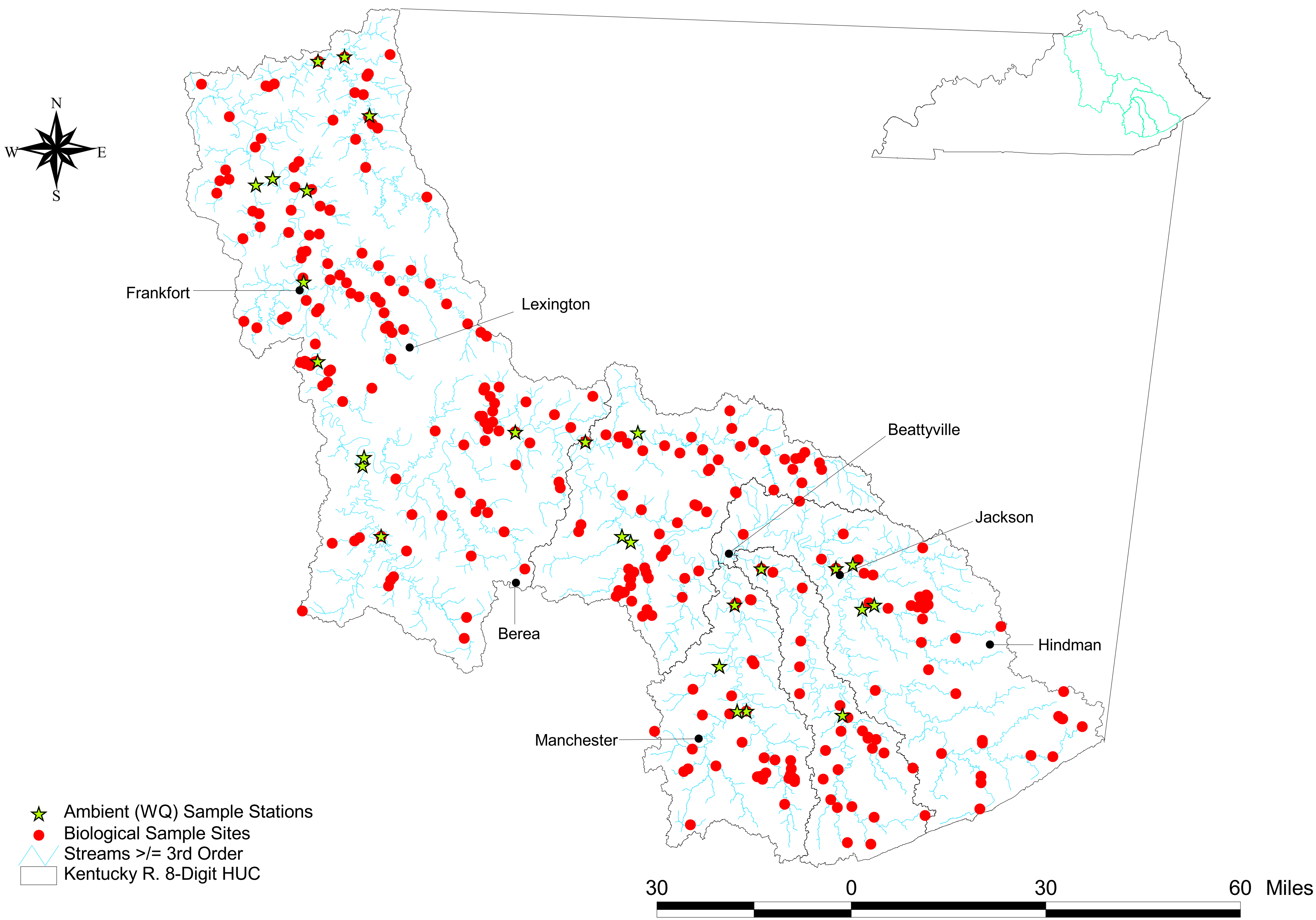


Figure 3.1.1-3. Targeted biological and ambeint water quality monitoring in Salt River Basin.

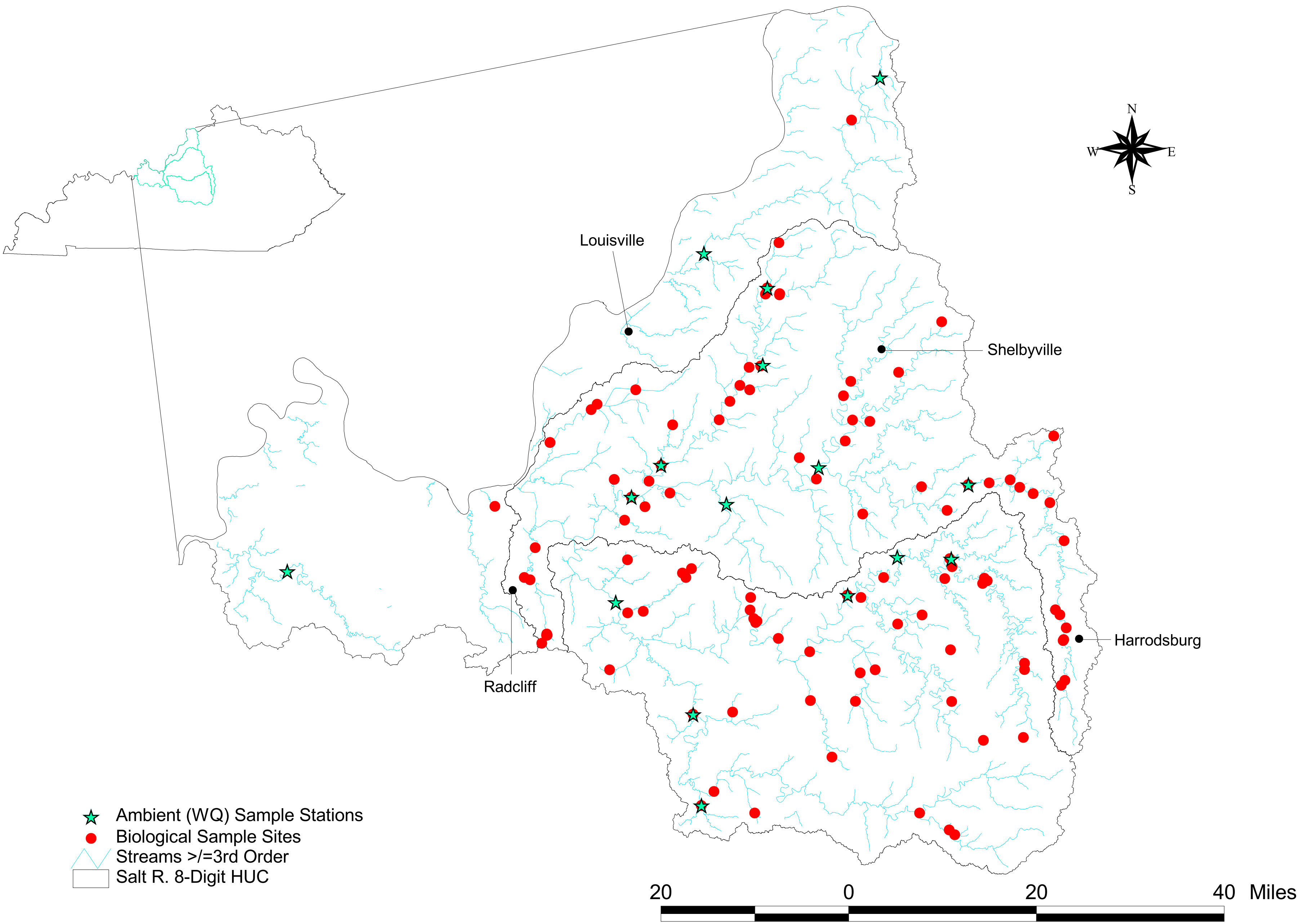
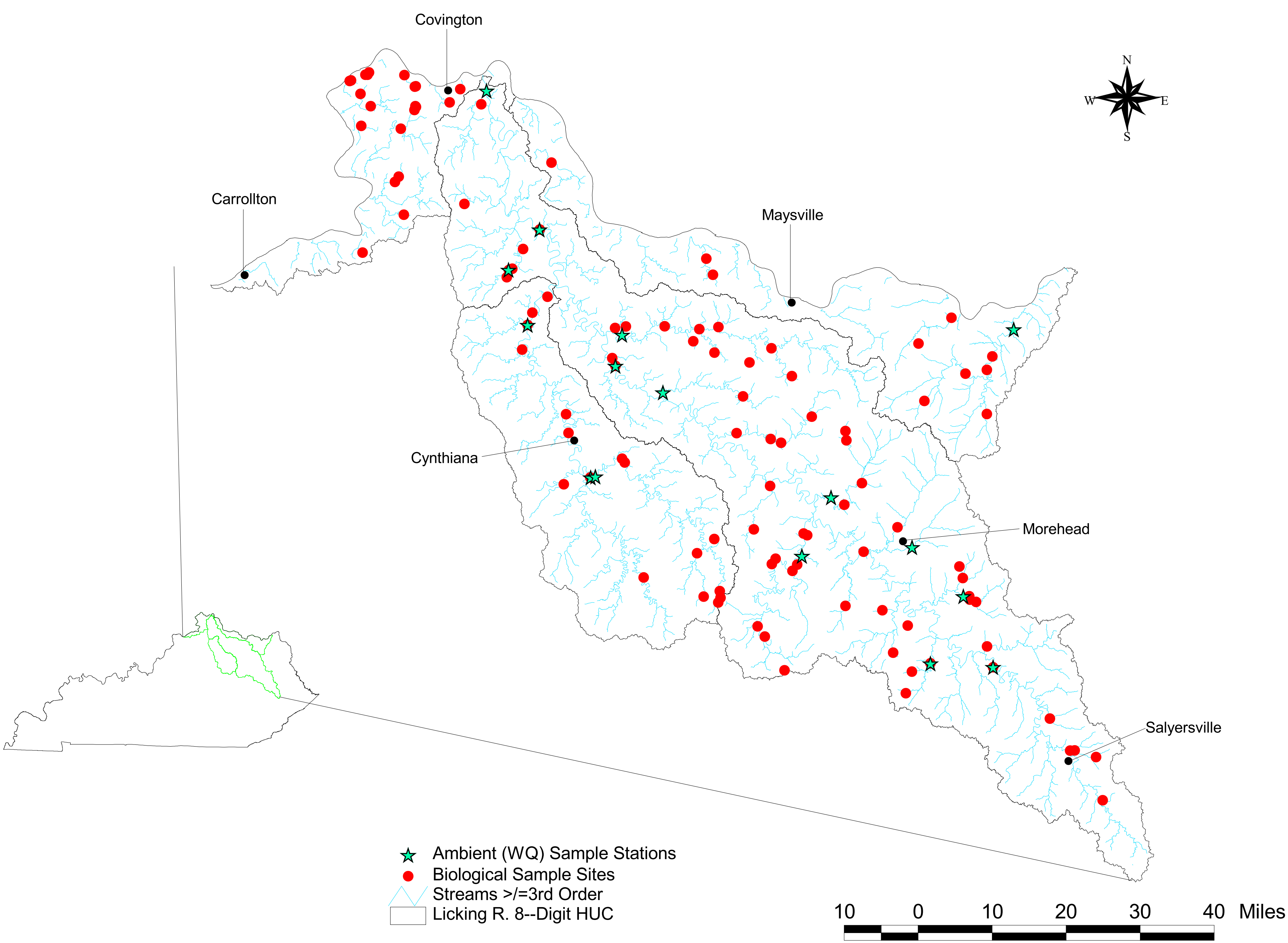


Figure 3.1.1-4. Targeted biological and ambient water quality monitoring in Licking River Basin.



3.1.2 Rotating Watershed Network

Water Quality. An inter-agency monitoring team established several objectives for the one-year watershed water quality monitoring stations. The objectives were to: (1) obtain an overall representation of the quality of the basin's water resources; (2) determine water quality conditions associated with major land cover/land uses such as forest, urban, agriculture and mining; (3) characterize the basin's least impacted waters; and (4) collect data for establishing total maximum daily loads (TMDLs) as required by Section 303(d) of the Clean Water Act. Field measurements are taken for pH, dissolved oxygen, specific conductance and temperature, and samples are analyzed for nutrients, metals and also pesticides and herbicides if the streams are in predominantly agricultural areas.

The Division of Environmental Services, the laboratory of the Kentucky Environmental and Public Protection Cabinet, analyzed water quality samples collected by DOW. The rotating watershed water quality monitoring network consisted of 12 stations in the Kentucky River BMU and 14 stations in the Salt and Licking rivers basins (Table 3.1.2-1). These usually were located at the downstream reaches of USGS 11-digit HUC (hydrologic unit code) watersheds, and many were coupled with biological sampling and with USGS gauging stations (Figures 3.1.2-1 and 3.1.2-2). Monthly sampling, sometimes complemented by rain event sampling, was conducted over the 12-month watershed monitoring period April 2003 – March 2004 in the Kentucky River BMU and April 2004 – March 2005 in the Salt-Licking Rivers BMU to characterize water quality of each watershed represented. The KDOW follows water quality sample collection and preservation procedures found in its water quality monitoring SOP (Kentucky Ambient/Watershed Water Quality Monitoring Standard Operating Procedure Manual, 2005).

3.1.3 Swimming Advisory Monitoring

DOW continued to sample areas with long-standing swimming advisories in three basins: 24 sites in the upper Cumberland River basin on seven streams, 20 sites in the Northern Kentucky area (lower Licking River Basin) and 29 sites in the North Fork Kentucky River Basin from Chavies to the headwater.

Table 3.1.2-1. Rotating watershed water quality stations.

Site ID	Stream	Latitude	Longitude	Mile Point	Description
		Kentucky River Basin (April 2003 – March 2004)			
KRW026	Tenmile Creek	38.7151	-84.7494	0.3	nr Folsom
KRW027	Eagle Creek	38.5831	-84.6801	49.4	nr Holbrook
KRW028	Sixmile Creek	38.4306	-85.0054	3.0	nr Lockport
KRW029	Cedar Creek	38.4172	-84.8604	2.2	nr Monterey
KRW030	Kentucky River	38.0345	-84.8348	87.0	nr Tyrone
KRW031	Dix River	37.8003	-84.7109	1.5	dam tailwaters
KRW032	Otter Creek	37.8709	-84.2791	1.7	nr Ford
KRW034	Station Camp Cr	37.621	-83.9594	11.1	nr Irvine
KRW035	Sexton Creek	37.3388	-83.7178	3.6	nr Taft
KRW036	Quicksand Cr	37.5591	-83.3367	2.6	nr Noctor
KRW037	Lost Creek	37.4588	-83.3134	1.9	nr Watts
KRW038	Red Lick Creek	37.6337	-83.9839	0.7	nr Jinks
		Salt River Basin (April 2004 – March 2005)			
SRW002	Chaplin River	37.8912	-85.1993	17.1	nr Chaplin
SRW005	Sinking Creek	37.8688	-86.3879	14.6	at Clifton Mills
SRW006	Harrods Creek	38.3611	-85.5748	7.3	nr Prospect
SRW008	Currys Fork	38.3074	-85.4506	0.3	nr Crestwood
SRW012	Floyds Fork	38.1899	-85.4581	33.0	at Fisherville
SRW013	Cox Creek	37.9737	-85.5421	2.7	nr Solitude
SRW014	Sulphur Creek	37.8878	-85.0938	0.8	at Sulphur Lick Creek Road
		Licking River Basin (April 2004 – March 2005)			
LRW001	Licking River	39.0631	-84.4954	2.4	at Newport
LRW003	S.F. Grassy Cr	38.7117	-84.4466	12.7	nr Falmouth
LRW007	Triplett Creek	38.1536	-83.4550	10.6	nr Morehead
LRW008	Blackwater Cr	37.9249	-83.4165	5.6	nr Ezel
LRW009	N.F. Licking R	38.0550	-83.3307	10.4	nr Leisure
LRW011	Johnson Creek	38.4671	-84.0660	0.8	nr Piqua
LRW012	Fox Creek	38.2547	-83.6529	2.8	nr Grange City

Figure 3.1.2-1. Kentucky River BMU rotating watershed water quality stations monitored in 2003.

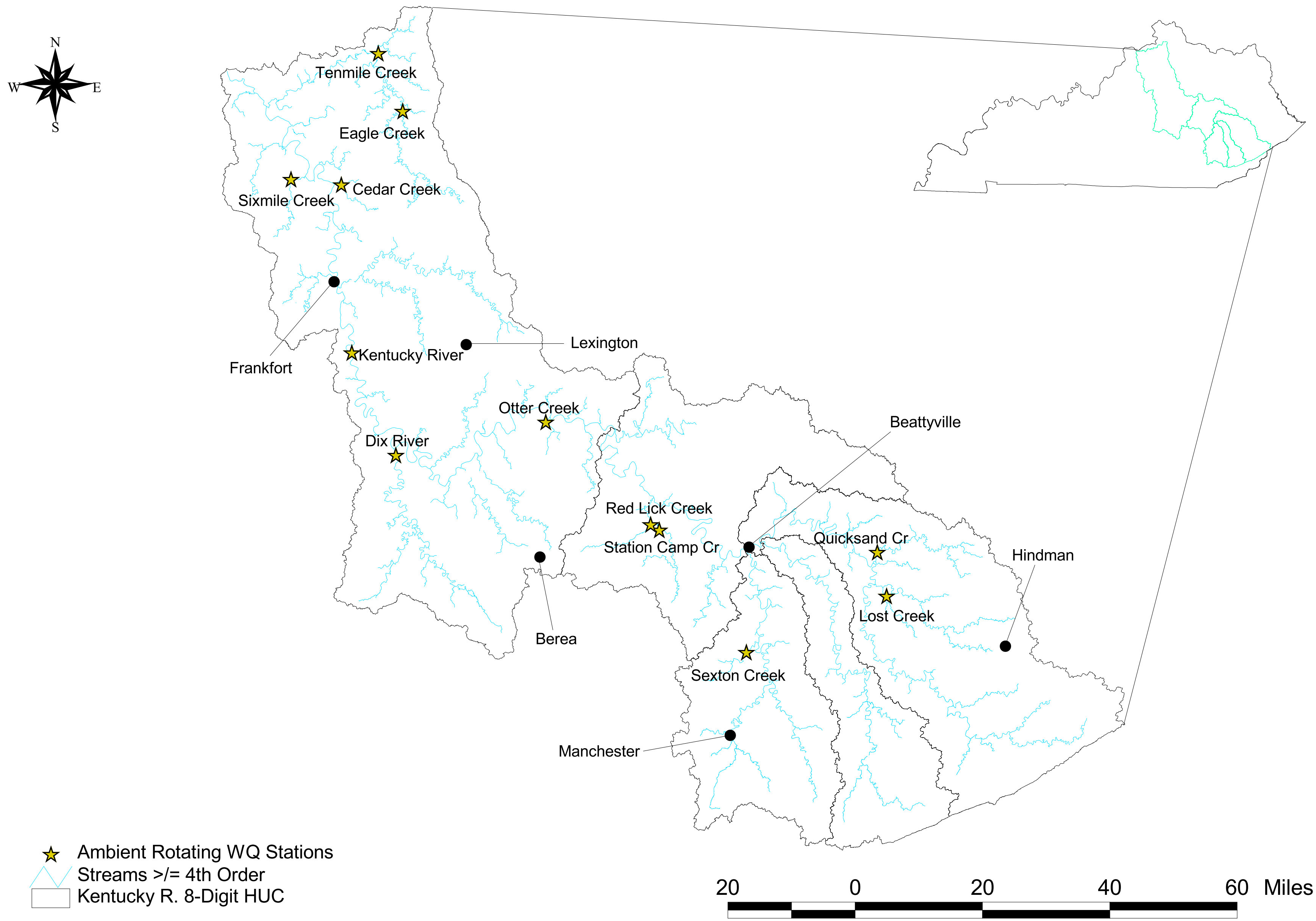
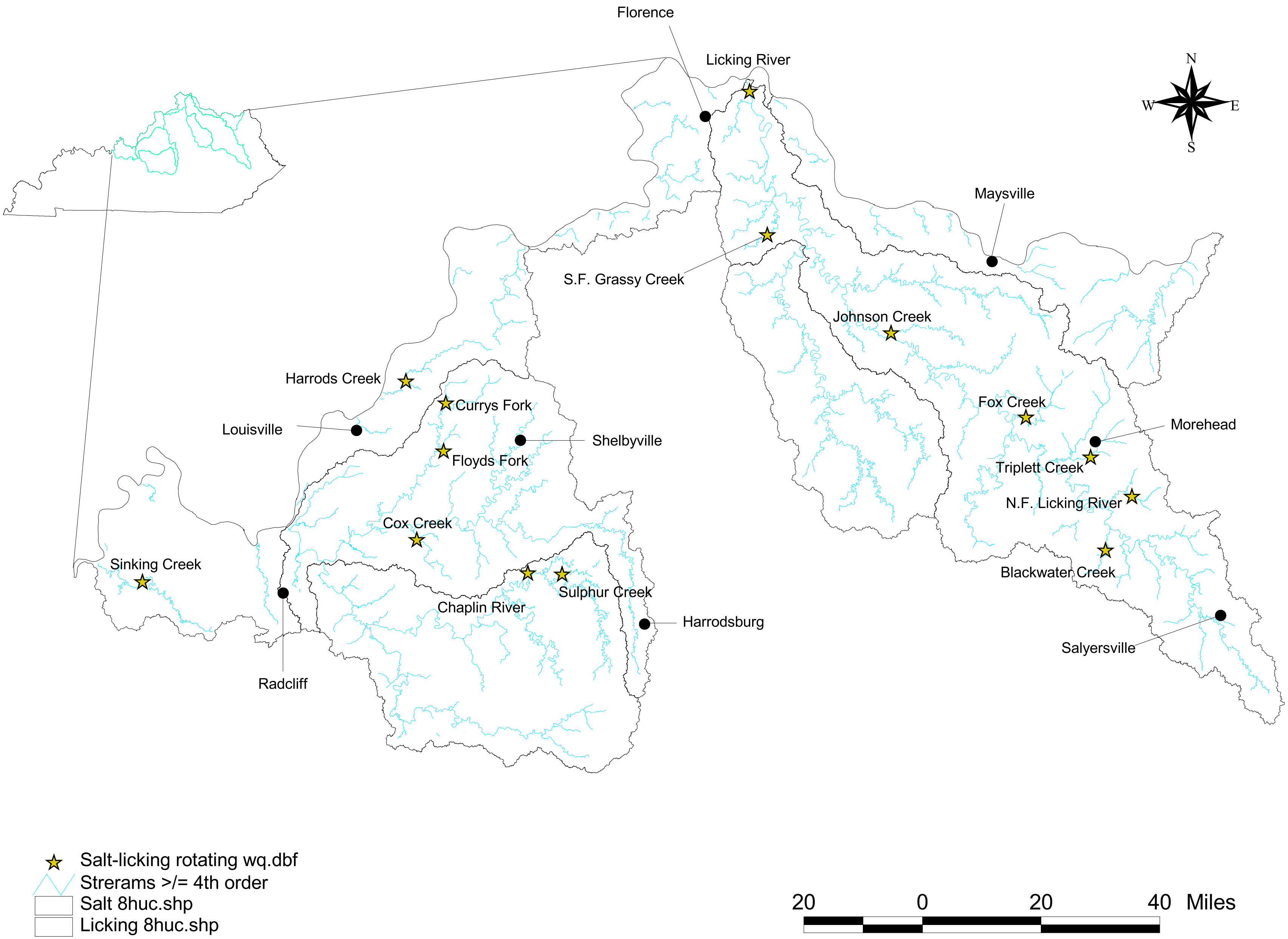


Figure 3.1.2-2. Salt-Licking BMU rotating watershed water quality stations monitored in 2004.



3.1.4 Biomonitoring and Biosurvey Programs

Introduction. There are four biological monitoring programs within DOW. Those programs have the primary purpose of assessing the aquatic life use support of streams in the commonwealth. Although each program is driven by broad objectives, together they provide a comprehensive program that addresses aquatic life use attainment from several approaches: 1) random, overall snapshot of the ambient conditions; 2) the integration of conditions in relatively large watersheds monitored for long-term trend evaluation; 3) impact assessments related to nonpoint source pollution; 4) impact assessments related to point source pollution; and 5) a regional reference program that assesses least impacted streams for development and refinement of metric benchmarks used to assess lotic (running water) ecosystems.

Reference Reach Program. In 1991, DOW began a Reference Reach (RR) program to gather data from the state's least impacted streams. Biologists first identified potential least impacted waters representative of geographic regions of the state known as ecoregions. Then, data on physicochemical water quality, sediment quality, fish tissue residue, habitat condition, and biotic conditions were collected to define the potential environmental quality for the streams of a particular ecoregion to provide a baseline to compare other streams in the same ecoregion to those reference conditions. Data from the reference reach program provided the basis for the development of narrative and numerical biocriteria for the various ecoregions of the commonwealth. Fifty-five stream sites from seven level III ecoregions were initially sampled in the spring and fall of 1992-1993. Since that time, many more potential reference reach streams were sampled. Some were adopted as reference reach streams; others were rejected because they did not possess adequate quality to represent least impacted condition. Currently, there are 52 RR streams totaling 490 miles throughout the commonwealth (Table 3.1.4-1). Another 85 streams totaling 421.5 miles will be considered for inclusion during the upcoming triennial review of water quality standards. There are 21 (188. 5 miles) existing and five proposed RR streams, or segments, equaling 22.5 miles in the two BMUs covered in this report Table 3.1.4-2).

Table 3.1.4-1. Reference reach streams[a] in Kentucky, with bold lettering identifying those in the Kentucky River and Salt-Licking BMUs.

Stream	County	Location	Basin	Start Segment	End Segment	Total Miles
Cane Creek	Whitley	0.1 mi below Daylight Branch	Upper Cumberland	11.5	7	4.5
Bark Camp Creek	Whitley	U.S. Forest Service Rd 193 bridge	Upper Cumberland	7.6	2.6	5
Eagle Creek	McCreary	KY 896 bridge	Upper Cumberland	6.3	3	3.3
South Fork Dog Slaughter Creek	Whitley	1000 ft above foot bridge (Dog Slaughter Falls Trail)	Upper Cumberland	4.6	0	4.6
Buck Creek	Pulaski	Off Bud Rainey Rd	Upper Cumberland	62.6	28.9	33.7
Marsh Creek	McCreary	KY 478 bridge	Upper Cumberland	26.2	12.6	13.6
Horse Lick Creek	Jackson	Horse Lick Creek Rd at first ford	Upper Cumberland	21.2	1.9	19.3
Bad Branch	Letcher	0.2 mi above KY 932 bridge	Upper Cumberland	3.0	0	3
Beaverdam Creek	Edmonson	KY 101-259 bridge	Green	14.0	7.6	6.4
Gasper River	Logan	0.2 mi above Bucksville Rd bridge	Green	38.0	32.3	5.7
Trammel Fork	Allen	0.1 mi below Red Hill Rd bridge	Green	30.15	19.4	10.75
Lick Creek	Simpson	0.1 mi above HWY 585 (265) bridge	Green	9.9	5.3	4.6
Peter Creek	Barren	HWY 3179; Oil Well Rd	Green	18.05	13.05	5
Caney Fork	Barren	0.1 mi below Hwy 3179 (Oil Well Rd)	Green	6.6	0.8	5.8
Falling Timber Creek	Metcalfe	Hwy 640 bridge crossing	Green	16.0	11.5	4.5
Russell Creek	Adair	0.15 mi below KY Hwy 80 at Gentry's Mill	Green	68.0	23.8	44.2
Goose Creek	Casey	Off Brock Rd	Green	14.6	5.6	9
Drennon Creek	**Henry**	**Flat Bottom Rd crossing**	**Kentucky**	**11.9**	**10.5**	**1.4**
Indian Creek	**Carroll**	**Hwy 36 bridge**	**Kentucky**	**4.7**	**0.55**	**4.15**
Musselman Creek	**Grant**	**Lawrenceville – Keefer Rd bridge**	**Kentucky**	**8.4**	**2.6**	**5.8**
Clear Creek	**Woodford**	**Hifner Rd bridge, 2.1 mi S of Mortonsville**	**Kentucky**	**19.0**	**4.1**	**14.9**
Station Camp Creek	**Estill**	**Off KY Hwy 1209 at Estill-Jackson County boundary**	**Kentucky**	**22.3**	**19**	**3.3**
South Fork Station Camp Creek	**Jackson**	**KY 89 bridge**	**Kentucky**	**48.6**	**5.3**	**43.3**
Sturgeon Creek	**Lee**	**Off Sturgeon Creek Rd**	**Kentucky**	**31.1**	**4**	**27.3**
Gladie Creek	**Menifee**	**0.2 mi upstream of bridge**	**Kentucky**	**8.4**	**0**	**8.4**
East Fork Indian Creek	**Menifee**	**1 mi upstream of West Fork Indian Cr**	**Kentucky**	**8.5**	**0**	**8.5**
Wolfpen Branch	**Menifee**	**at KY 715 bridge**	**Kentucky**	**3.3**	**0**	**3.3**
Right Fork Buffalo Creek	**Owsley**	**Off Whoopflarea Rd**	**Kentucky**	**11.2**	**0**	**11.2**
Buffalo Creek	**Owsley**	**Side road along mainsteam**	**Kentucky**	**12.8**	**0.8**	**12**
Coles Fork	**Breathitt**	**in Robinson Forest**	**Kentucky**	**5.5**	**0**	**5.5**
Elisha Creek	**Leslie**	**Elisha Creek Road**	**Kentucky**	**3.3**	**0.95**	**2.35**
Line Fork Creek	**Letcher**	**off KY 160**	**Kentucky**	**27.5**	**17.3**	**10.2**
North Fork Licking River	**Morgan**	**0.1 mi below Bucket Branch**	**Licking**	**21.3**	**13**	**8.3**
Bucket Branch	**Morgan**	**Leisure – Paragon Rd bridge**	**Licking**	**1.9**	**0**	**1.9**
Devils Fork	**Morgan**	**KY 711 bridge**	**Licking**	**7.8**	**0**	**7.8**
Big Sinking Creek	Carter	KY 986 bridge	Little Sandy	15.2	10.7	4.5
Arabs Fork	Elliott	KY 1620 bridge	Little Sandy	4.7	0	4.7
Big Caney Creek	Elliott	off KY 32, Binion Ford Rd	Little Sandy	15	2.2	12.8
Laurel Creek	Elliott	Carter School Rd bridge	Little Sandy	14.4	7.6	6.8
Yellowbank Creek	Breckinridge	Cart-Manning Crossing Rd Wildlife Management Area	Ohio	11.9	4.4	7.5

Table 3.1.4-1 (cont.). Reference reach streams[a] in Kentucky, with bold lettering identifying those in the Kentucky River and Salt-Licking BMUs.

Stream	County	Location	Basin	Start Segment	End Segment	Total Miles
Soldier Creek	Marshall	HWY 58 bridge	Tennessee	5.3	2.6	2.7
Panther Creek	Calloway	KY 280 bridge	Tennessee	5.1	1.2	3.9
Blood River	Calloway	Grubbs Lane bridge; O.75 mi E of State Line Rd	Tennessee	15.65	15.1	0.55
Tradewater River	Christian	J. T. Sparkman Rd; 0.7 mi from Mt. Zoar Rd	Tradewater	132.3	126	6.3
Sandlick Creek	Christian	Mt. Carmel-Camp Cr. Rd; 0.75 mi W of KY Hwy 109	Tradewater	9.0	3.5	5.5
Wilson Creek	**Bullitt**	**Mt. Carmel Church Rd, first crossing**	**Salt**	**17**	**12.2**	**4.8**
Salt Lick Creek	**Marion**	**Off Salt Lick Rd**	**Salt**	**8.4**	**5.3**	**3.1**
Otter Creek	**Larue**	**0.1 mi below West Fork, Herbert-Howell Rd**	**Salt**	**2.7**	**1.75**	**0.95**
West Fork Red River	Christian	Carter Rd bridge	Lower Cumberland	26.5	16.3	10.2
Whippoorwill Creek	Logan	KY Hwy 2375 bridge	Lower Cumberland	44.6	0	44.6

A result of the development of Reference Reach scoring for the four bioregions in Kentucky is the identification of Exceptional streams and segments. These 35 streams and segments, totaling 94.5 miles, are listed in commonwealth regulations (401 KAR 5:030) for anti-degradation purposes. A list of candidate Exceptional and RR streams are presented in Table 3.1.4-2. These streams and segments will be considered for official inclusion in 401 KAR 5:030 during the next triennial review.

Watershed Biological Monitoring Program (WBMP). The WBMP monitors streams in a fixed-station network so long-term trends can be tracked in the targeted fourth and fifth order watersheds (Figures 3.1.1-1, 3.1.1-2 and 3.1.1-3). Targeted stations were placed in the downstream reaches of fourth, fifth and occasionally sixth order (on 1:24,000 scale USGS topographic maps) watersheds. These stations were chosen because the number of these watersheds closely matched the available monitoring resources, and these watersheds were more hydrologically accurate and uniform in size than 11-digit watersheds.

A biosurvey is conducted at these stations, which typically include two or three biological communities (macroinvertebrates, fishes, or diatoms), to determine the condition of wadeable streams. Also collected are nutrient samples (un-ionized ammonia, nitrite-nitrate, total phosphorus, and total Kjeldahl-nitrogen) and bulk water

Table 3.1.4-2. Candidate reference reach and exceptional (401 KAR 5:030) streams and segments in the Kentucky River BMU and Salt-Licking BMU.

Basin	Stream	Segment Description	Segment Mile Points	Total Miles	Lat-Long (downstream)	Lat-Long (upstream)	County	Reference[a] or Exceptional[b]
Kentucky	Rock Lick Cr.	Mouth to Headwaters	0.0-9.6	9.6	37.53939 -84.01041	37.54762 -83.15038	Jackson	Reference
	Lower Howard Cr.	Mouth to West Fork	0.0-2.7	2.7	37.91802 -84.27256	37.93369 -84.26951	Clark	Exceptional
	Backbone Cr.	Mouth to Scrabble Cr.	0.0-1.7	1.7	38.33978 -84.99688	38.32024 -84.99354	Franklin, Henry, Shelby	Reference
	Sulphur Creek	Mouth to Headwaters	0.0-5.2	5.2	38.28752 -84.80238	38.30562 -84.74529	Franklin	Reference
	Craig Creek	Mouth to UT	0.0-2.7	2.7	37.97908 -84.8206	37.98133 -84.78473	Woodford	Reference
	Bear Branch	Above Sediment Pond to Headwaters	0.3-1.2	0.9	37.13216 -83.10139	37.12607 -83.11332	Perry	Exceptional
	Billey Fork	Land Use Change to Headwaters	2.6-8.8	6.2	37.6796 -83.7965	37.7254 -83.7250	Lee	Exceptional
	Cherry Run	Mouth to Boyd Run	0.0-0.9	0.9	38.21315 -84.48522	38.21726 -84.47431	Scott	Exceptional
	Gilberts Creek	Mouth to UT	0.0-2.6	2.6	37.97366 -84.81863	37.97570 -84.85231	Anderson	Exceptional
	Honey Branch	Mouth to Headwaters	0.0-1.4	1.4	37.01756 -83.35499	37.00966 -83.37233	Leslie	Exceptional
	Katies Creek	Mouth to Headwaters	0.0-4.0	4.0	37.0349 -83.5399	37.0177 -83.5964	Clay	Exceptional
	Little Middle Fk. Elisha Creek	Mouth Headwaters	0.0-0.75	0.75	37.08173 -8351566	37.08750 -83.50586	Leslie	Exceptional
	*Middle Fk. Kentucky River	Hurts Creek to Greasy Creek	75.9-84.3	9.4	37.15529 -83.3704	37.07655 -83.39242	Leslie	Exceptional
	Right Fk. Elisha Cr.	Mouth to Headwaters	0.0-3.3	3.3	37.08165 -83.51802	37.07601 -83.46882	Leslie	Exceptional
	Shaker Creek	Near Mouth to Shawnee Run	0.1-1.4	1.3	37.84727 -84.76563	37.84374 -84.76813	Mercer	Exceptional

Table 3.1.4-2 (cont.). Candidate reference reach and exceptional (401 KAR 5:030) streams and segments in the Kentucky River BMU and Salt-Licking BMU.

Basin	Stream	Segment Description	Segment Mile Points	Total Miles	Lat-Long (downstream)	Lat-Long (upstream)	County	Reference[a] or Exceptional[b]
Kentucky	*Spruce Branch	Mouth to Headwaters	0.0-1.0	1.0	36.95706 -83.53100	36.94948 -83.51666	Clay	Exceptional
	Steeles Run	Mouth to UT	0.0-4.2	4.2	38.11101 -84.62885	38.06734 -84.59552	Fayette	Exceptional
	UT of Jacks Creek	Mouth to Headwaters	0.0-1.15	1.15	37.85200 -84.36529	37.85177 -84.34607	Madison	Exceptional
	UT of Kentucky R.	Near Mouth to Land Use Change	0.1-1.4	1.3	38.219102 -84.87777	38.23174 -84.8624	Franklin	Exceptional
Licking	Blanket Creek	Mouth to UT	0.0-1.9	1.9	38.65566 -84.28532	38.64272 -84.29925	Pendleton	Exceptional
	Bowman Creek	Mouth to UT	0.0-6.0	6.0	38.89256 -84.44239	38.89406 -84.50250	Kenton	Exceptional
	Cedar Creek	Mouth to N. Br. Cedar Cr.	0.0-1.7	1.7	38.47647 -84.12288	38.49034 -84.10738	Robertson	Exceptional
	Flour Creek	Mouth to UT	0.0-2.2	2.2	38.78912 -84.34401	38.80180 -84.32476	Pendleton	Exceptional
	Sawyers Fork	Mouth to Headwaters	0.0-3.3	3.3	38.84833 -84.54032	38.82288 .84.58491	Kenton	Exceptional
	*Slabcamp Creek	Mouth to Headwaters	0.0-3.7	3.7	38.09982 -83.32884	38.13916 -83.3548	Rowan	Exceptional
	Slate Creek	Mouth to Mill Creek	0.0-13.6	13.6	38.21835 -83.69838	38.11217 -83.74668	Bath	Exceptional
	UT of Shannon Cr.	Mouth to Headwaters	0.0-2.2	2.2	38.55437 -83.93334	38.52929 -83.94689	Mason	Exceptional
	Little South Fork	Land Use Change to Headwaters	1.2-5.9	4.7	38.82221 -84.74072	38.82854 -84.68526	Boone	Exceptional
	Doctors Fork	Mouth to Begley Branch	0.0-3.8	3.8	37.67561 -84.968583	37.64618 -84.99938	Boyle	Exceptional

Table 3.1.4-2 (cont.). Candidate reference reach and exceptional (401 KAR 5:030) streams and segments in the Kentucky River BMU and Salt-Licking BMU.

Basin	Stream	Segment Description	Segment Mile Points	Total Miles	Lat-Long (downstream)	Lat-Long (upstream)	County	Reference[a] or Exceptional[b]
Salt	Indian Creek	Mouth to UT	0.0-0.9	0.9	37.85122 -84.97894	37.85371 -84.96872	Mercer	Exceptional
	Lick Creek	Mouth to 0.1 mi below dam	0.0-4.1	4.1	37.81839 85.21555	37.82618 85.16398	Washington	Exceptional
	UT of Glens Creek	Mouth to Headwaters	0.0-2.3	2.3	37.85772 -85.12185	37.85101 -85.08582	Washington	Exceptional

[a]Reference Reach streams and segments have the greatest biological integrity and intact habitat of those streams in a given bioregion.
[b]Exceptional streams and segments must score “excellent” on the Macroinvertebrate Biotic Index (MBI) or Kentucky Index of Biotic Integrity (KIBI) based on 50th percentile for Mountain, Bluegrass and Pennyroyal and 75th percentile for the Mississippi Valley-Interior River Lowlands bioregions.
*Streams that are already Exceptional in 401 KAR 5:030 but are proposed for a segment change based on new data or to conform to NHD mile points.

quality variables (total suspended solids, chlorides, sulfates, alkalinity, hardness and total organic carbon). Physicochemical measurements are also made at time of water quality sample collection; a Hydrolab multiparameter probe is used to measure pH, temperature, DO, percent DO saturation and specific conductance. Often, ambient water quality data are collected at these locations on a monthly basis during the BMU-cycle. These stations are revisited every five years.

Nonpoint Source Program (NPSP). The Kentucky Nonpoint Source Pollution Control Program is designed to protect the quality of Kentucky's surface and groundwater from NPS pollutants, abate NPS threats and restore degraded waters to the extent that water quality standards are met and beneficial uses are supported. The NPSP is achieving these goals through federal, state, local and private partnerships which promote complementary, regulatory and non-regulatory nonpoint source pollution control initiatives at both statewide and watershed levels.

Nonpoint source pollution is also known as runoff or diffuse pollution. Unlike pollution from industrial and sewage treatment plants, NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and even underground water. These pollutants include:

- Excess fertilizers, herbicides and insecticides from agricultural lands and residential areas;
- Oil, grease and toxic chemicals from urban runoff and energy production;
- Sediment from improperly managed construction sites, crop and silviculture lands and eroding streambanks;
- Acid mine drainage; and
- Pathogens and nutrients from livestock, wildlife, pet wastes and faulty septic systems.

Atmospheric deposition and hydromodification are also sources of nonpoint source pollution. NPS pollution is the number one contributor to water pollution in Kentucky.

Monitoring of streams impacted by NPS pollutants follows KDOW standard protocol and each biosurvey is conducted at these sites (which typically include two biological communities: macroinvertebrates and fishes), to determine the condition of wadeable streams. Collections for nutrient samples (un-ionized ammonia, nitrite-nitrate, total phosphorus, and total Kjeldahl-nitrogen) and bulk water quality variables (total suspended solids, chlorides, sulfates, alkalinity, hardness and total organic carbon) are made at these sites. Physicochemical measurements are also made at time of water quality sample collection; a Hydrolab multiparameter probe is used to measure pH, temperature, DO, percent DO saturation and specific conductance.

Probabilistic Monitoring Program (PMP). DOW conducts random biosurveys of streams across the commonwealth. Each year the Probabilistic Biosurvey Program Coordinator selects watersheds on the 8-digit HUC level to be monitored in a particular BMU. The target population is all wadeable streams 1st through 5th order within the cataloging units of each BMU. Then a request is sent to EPA's National Health and Environmental Research Laboratory, Office of Research and Development, Corvallis, Oregon, where the EMAP Design Group uses EPA's Reach File Version 3 – Alpha (RF3-Alpha) as a sampling frame. A frequency table is established for the population candidate streams (based on stream order) across the HUCs and, based on those frequencies, a random weighted survey design is utilized to determine those streams and the locations of the sample points for the study. A sample size of 50 sites with approximately an equal number in each of the five categories: 1st, 2nd, 3rd, 4th and 5th combined. An oversample of 200% (100 sites) for a total of 150 sites, including the base sites are derived per study. This oversample provides extra/reserve samples for alternative sites for sampling for those initial sites that do not conform to target population rules (e.g. nonwadeable, mis-mapped features) or are inaccessible due to safety concerns or denied access by landowners. Standard protocol dictates that surrogate stream sample sites be selected sequentially from the oversample population when replacement of an initial sample site is necessary. Since the random design is weighted, no regard to replacement of an initial sample site with one of "equal" stream order is required.

A biosurvey of the macroinvertebrate community is conducted to determine condition of wadeable streams. Additionally, the probabilistic program also collects nutrient samples (un-ionized ammonia, nitrite-nitrate, total phosphorus, and total

Kjeldahl-nitrogen) in addition to bulk water quality variables (total suspended solids, chlorides, sulfates, alkalinity, hardness and total organic carbon). Physicochemical measurements are also made at time of water quality sample collection; a Hydrolab multiparameter probe is used to measure pH, temperature, DO, percent DO saturation and specific conductance. For this reporting cycle, probabilistic network consisted of 100 sites (50 stations per BMU (Kentucky River and Salt-Licking)). Those sites, along with stream names, are presented in Tables 3.1.4-3 through 3.1.4-5 and Figures 3.1.4-1 and 3.1.4-2.

Table 3.1.4-3. Key to stream names sampled and assessed in the Kentucky River BMU using probabilistic methodology.

1. Sturgeon Creek
2. Katies Creek
3. Lotts Creek
4. Lick Creek
5. S. Fork Quicksand Creek
6. Silver Creek
7. Cane Creek
8. [a]UT of Hanging Fork
9. Billey Fork
10. Caney Creek
11. [a]UT of Engle Fork
12. S. Elkhorn Creek
13. [a]UT of Tanyard Branch
14. Muncy Creek
15. Red River
16. Hall Branch
17. Little Willard Creek
18. Knob Lick Creek
19. Mill Creek
20. Troublesome Creek
21. White Oak Creek
22. Johnson Fork
23. Meadow Creek
24. Shop Fork
25. Bailey Run
26. Horse Creek
27. Stinnett Creek
28. Red River
29. Station Camp Creek
30. Snow Creek
31. Cedar Creek
32. Troublesome Creek
33. Frozen Creek
34. Clarks Creek
35. Squabble Creek
36. Copper Creek
37. Line Fork
38. N. Severn Creek
39. R. Fork Buffalo Creek
40. [a]UT of N. Elkhorn Creek
41. Meadow Creek
42. Big Laurel Creek
43. N. Elkhorn Creek
44. Buckhorn Creek
45. Sugar Creek
46. Chambers Fork
47. S. Elkhorn Creek
48. Middle Fork Kentucky R.
49. Indian Creek
50. [a]UT of Upper Howard Creek

[a]UT= Unnamed tributary

Figure 3.1.4-1. Probabilistic biological survey sites in the Kentucky River Basin Management Unit (key to stream names on previous page).

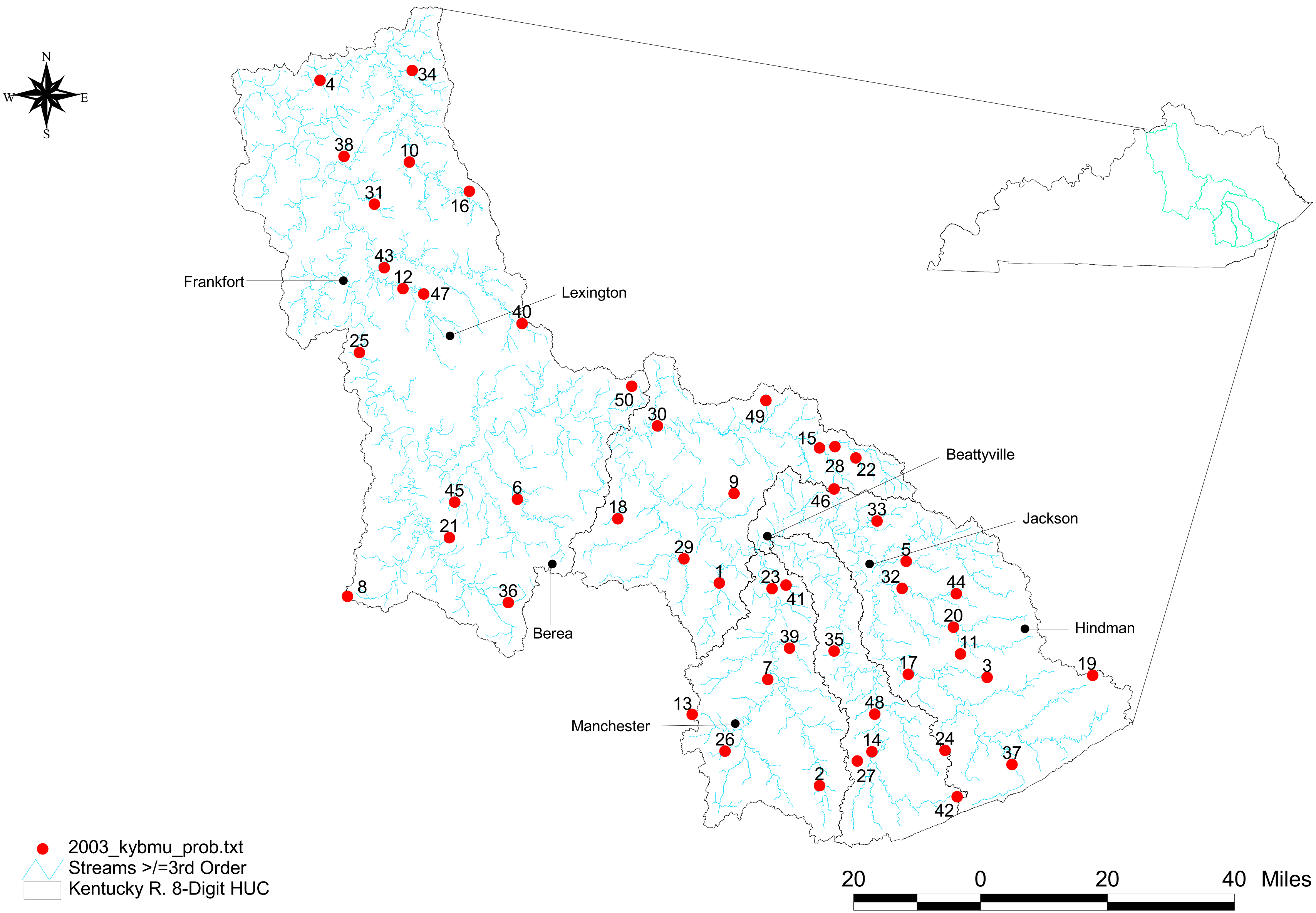


Table 3.1.4-4. Key to stream names sampled and assessed in Salt River Basin using probabilistic methodology.

1. Hardins Creek	13. Gravel Creek
2. Long Lick Creek	14. UT of Guist Creek
3. Floyds Fork	15. Long Lick Creek
4. Salt River	16. UT of Glens Creek
5. Tioga Creek	17. Ashes Creek
6. UT of Buffalo Run	18. Pennsylvania Run
7. UT of Hammond Creek	19. Big South Fork
8. Beech Fork	20. Short Creek
9. UT of Salt River	21. Bullskin Creek
10. Wilson Creek	22. Road Run
11. UT of Southern Ditch	23. Salt River
12. Monks Creek	

[a]UT= Unnamed tributary

Figure 3.1.4-2. Probabilistic biological survey sites in Salt River Basin (key to stream names on previous page).

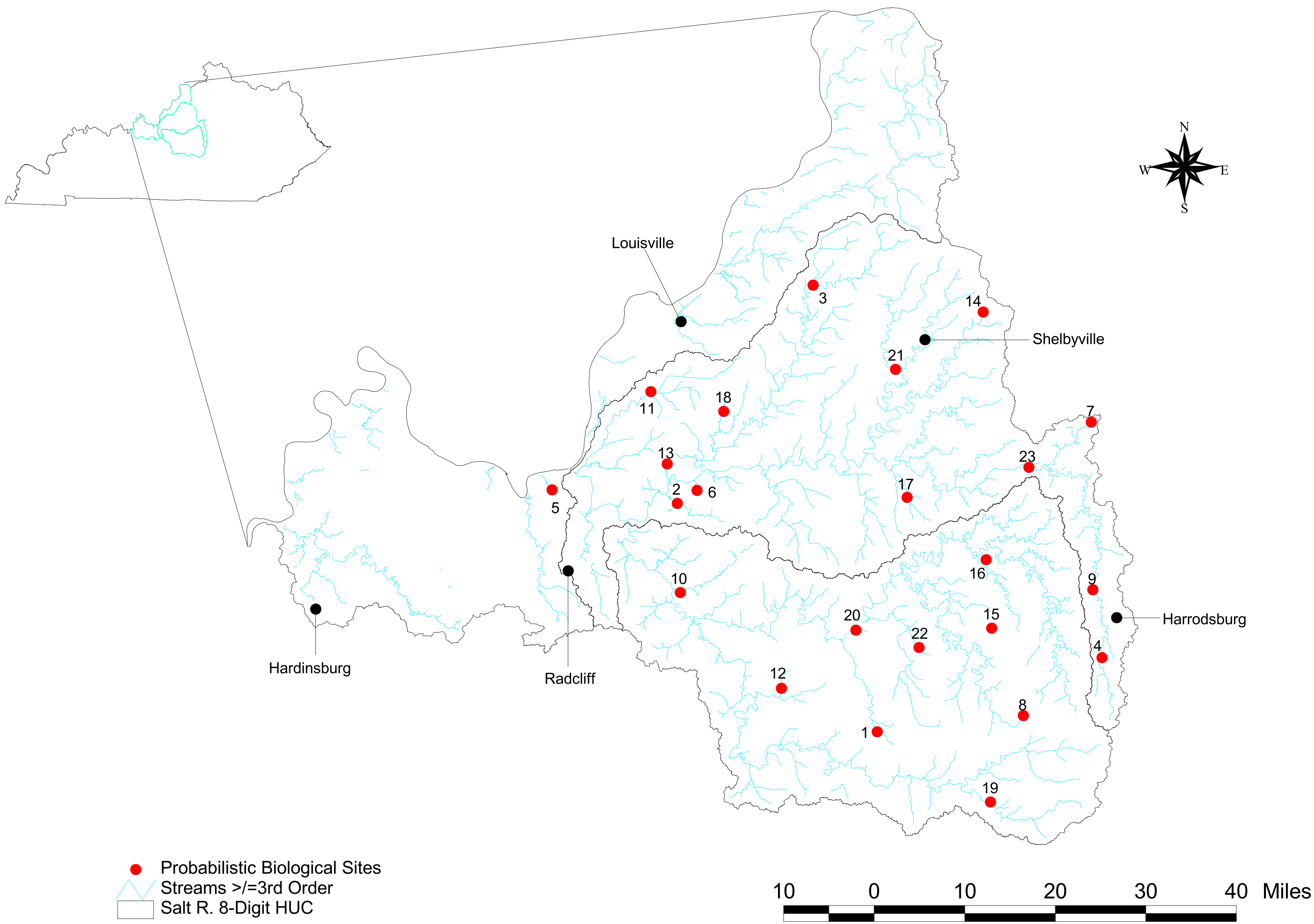
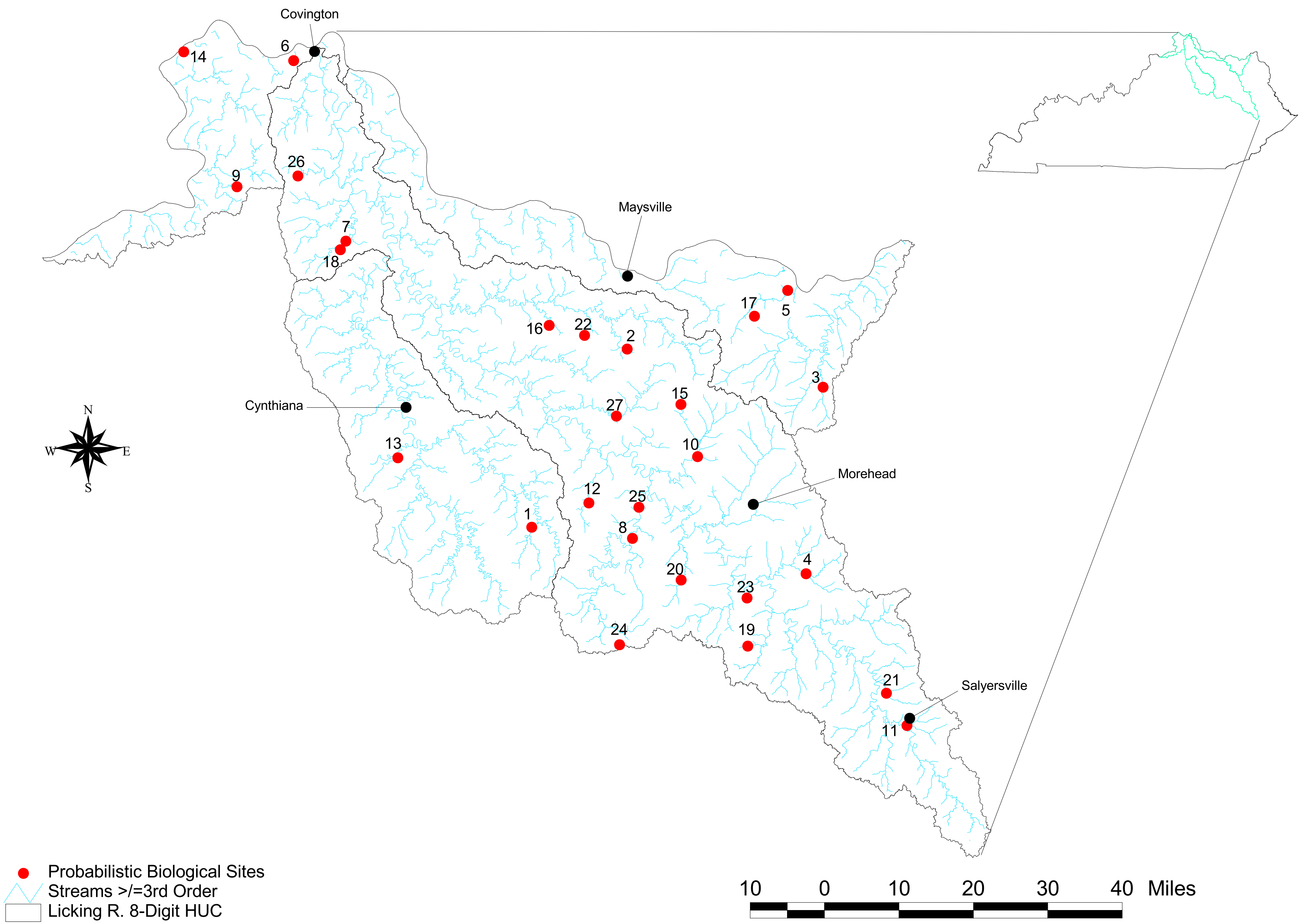


Table 3.1.4-5. Key to stream names sampled and assessed in Licking River Basin using probabilistic methodology.

1. Grassy Lick Creek	15. Sand Lick Creek
2. Mill Creek	16. Shannon Creek
3. Grassy Fork	17. Clary Branch
4. North Fork	18. Brushy Fork
5. Salt Lick Creek	19. Broke Leg Creek
6. Pleasant Run Creek	20. Salt Lick Creek
7. S. Fork Grassy Creek	21. Lick Creek
8. Slate Creek	22. UT Lees Creek
9. Little South Fork	23. Lick Creek
10. Crane Creek	24. Salt Spring Branch
11. Licking River	25. Cooks Branch
12. Flat Creek	26. Sawyers Fork
13. Townsend Creek	27. Fleming Creek
14. Second Creek	

[a]UT= Unnamed tributary

Figure 3.1.4-3. Probabilistic biological survey sites in Licking River Basin (key to stream names on previous page).



3.1.5 Lake and Reservoir Monitoring

Lakes and reservoirs are monitored over the growing season (April – October) for determination of trophic status using the Carlson Trophic State Index (TSI) for chlorophyll *a*. This method of determining trophic status of lakes allows lakes to be ranked numerically according to increasing trophic state: oligotrophic (low in plant nutrients); mesotrophic (water that is only moderately enriched in plant nutrients); eutrophic (water enriched in plant nutrients); and hyper-eutrophic (greatest abundance of plant nutrients). The growing season average TSI value is used to rank each lake.

A spring, summer and fall monitoring event occurs with an interval of six to eight weeks to allow sufficient time for seasonal changes to occur. All publicly accessible lakes and reservoirs make up the population of these resources monitored in Kentucky. Water quality variables, including nutrients (un-ionized ammonia, nitrite-nitrate, total phosphorus, TKN, total soluble (total dissolved) phosphorus, soluble reactive orthophosphate and total organic carbon), chlorophyll *a*, standard variables (total suspended solids, chlorides, sulfates, alkalinity and hardness) and a profile of water column physical data (DO, pH, temperature and specific conductance) (using a multiparameter probe) are monitored at each station per lake per sample event. The majority of these waters are small, usually several hundred acres or less in surface area; therefore, one sample station in the forebay is sufficient to characterize the status of the smaller lakes and reservoirs.

The Louisville and Nashville COE Districts cooperate in monitoring their dam projects in each BMU. The DOW monitors those reservoirs in the Huntington District of eastern Kentucky. The same data described above are used to determine the trophic status of each reservoir. Multiple monitoring stations are placed in these large reservoirs. Often, the major in-flow and out-flow tributaries of each reservoir are monitored for water quality as well. These tributary streams are assessed for aquatic life use support based on the physicochemical data.

Those lakes and reservoirs monitored in the Kentucky River and Salt-Licking Rivers BMUs are presented in Table 3.1.5-1. Maps of use support assessment results follow in Assessment Results, section 3.3.

Table 3.1.5-1. Lakes and reservoirs monitored in the Kentucky River and Salt-Licking BMUs during the 2003 and 2004, respectively.

Lake or Reservoir Name	Size (acres)	County	Basin	Latitude (dd)	Longitude (dd)
Bert Combs	36	Clay	Kentucky	37.16667	-83.7075
Boltz	92	Grant	Kentucky	38.70333	-84.6125
Buckhorn	1230	Perry	Kentucky	37.30444	-83.4483
Bullock Pen	134	Grant	Kentucky	38.79333	-84.6447
Carr Fork	710	Knott	Kentucky	37.23056	-83.0333
Cedar Creek	784	Lincoln	Kentucky	37.49271	-84.5522
Corinth	139	Grant	Kentucky	38.5	-84.5822
Elmer Davis	149	Owen	Kentucky	38.4975	-84.8778
Fishpond	32	Letcher	Kentucky	37.16167	-82.6772
General Butler State Park	29	Carroll	Kentucky	38.665	-85.1486
Herrington	2940	Garrard	Kentucky	37.74583	-84.7039
Reba	78	Madison	Kentucky	37.74111	-84.2519
Mill Creek	41	Wolfe	Kentucky	37.76861	-83.6683
Owsley Fork	152	Madison	Kentucky	37.54306	-84.1833
Panbowl	98	Breathitt	Kentucky	37.575	-83.375
Stanford City	43	Lincoln	Kentucky	37.48667	-84.68
Wilgreen	169	Madison	Kentucky	37.71222	-84.3453
Beaver	158	Anderson	Salt	37.96250	-85.02222
Guist	317	Shelby	Salt	38.20778	-85.14194
Jericho	137	Henry	Salt	38.45194	-85.28222
Long Run	27	Jefferson	Salt	38.26694	-85.41806
Marion County Sportsman	21	Marion	Salt	37.51500	-85.24583
McNeely	51	Jefferson	Salt	38.10250	-85.63528
Reformatory	54	Oldham	Salt	38.39778	-85.43778
Shelby	17	Shelby	Salt	38.23306	-85.21722
Sympson	184	Nelson	Salt	37.80750	-85.50472
Taylorsville	3050	Spencer	Salt	38.00144	-85.30394
A. J. Jolly	204	Campbell	Licking	38.88306	-84.37417
Doe Run	51	Kenton	Licking	38.98861	-84.55194
Greenbriar	66	Montgomery	Licking	38.01972	-83.85944
Kincaid	183	Pendleton	Licking	38.71583	-84.27667
Carnico	114	Nicholas	Licking	38.34667	-84.04167
Sand Lick Creek	74	Fleming	Licking	38.38972	-83.61139
Williamstown	300	Grant	Licking	38.67781	-84.51984
Cave Run	8270	Menifee	Licking	38.11764	-83.52936

3.2 Assessment Methodology

General Assessment Methods. Beginning with the 2005 electronic 305(b) report submittal, the commonwealth began assigning assessed uses, and any associated nonassessed uses, of stream segments and lakes to the appropriate category of the five reporting categories recommended by EPA (2005). Of those categories, two categories have been divided to better define assessment results, categories 2B and 5B were added by KDOW to better track assessed segments. Those categories used by the commonwealth are listed in Table 3.2-1. Many water body segments had only monitoring data for one use assessment, typically aquatic life use.

Table 3.2-1. Reporting categories assigned to surface waters during the assessment process.

Category	Definition
1	All designated uses for water body fully supporting.
2	Assessed designated use(s) is/are fully supporting, but not all designated uses assessed.
2B	Segment currently supporting use(s), but 303(d) listed & awaiting EPA approved delisting, or approved/established TMDL.
3	Designated use(s) has/have not been assessed (insufficient or no data available).
4A	Segment with an EPA approved or established TMDL for all listed uses not attaining full support.
4B	Nonsupport segment with an approved alternative pollution control plan (e.g. BMP) stringent enough to meet full support level of all uses within a specified time.
4C	Segment is not meeting full support of assessed use(s), but this is not attributable to a pollutant or combination of pollutants.
5	TMDL is required.
5B	Segment is not supporting use based on evaluated data; does not require a TMDL.

When considering waters for assessment, KDOW solicits data from a variety of entities. This includes other government agencies, including state agencies (e.g. Department of Fish & Wildlife, Nature Preserves Commission) and federal agencies including COE, F&WS, USGS, and TVA. Also, data from universities and volunteer monitoring groups are considered. Prior to 2004 KDOW considered volunteer monitoring data for screening purposes only; however, with proper SOP and QAPP, these data are considered to make assessment decisions. There were no data submitted by volunteer groups under an approved QAPP for assessment consideration in this IR. Meetings with volunteer groups continue and good progress is being made toward utilizing their quality assured data for future assessment.

Generally, data older than five years were not considered for assessment; however, assessment decisions were made on a case-by-case basis—not all data older than five years were excluded from consideration. If the only data available for a water body were older than five years, those data were considered.

A number of impairments or causes (term used prior to 2006 EPA IR guidance) in EPA's 2006 IR guidance were considered pollution rather than pollutants. Noting the ramifications of impairments are important since a water body found not supporting a use and shown to be impaired by pollution, without identified pollutants, does not require a TMDL, rather an alternative plan to bring the use back to full support. Those impairments considered pollution may be found in Table 3.2-2. The rationale behind pollutant vs. pollution is that a pollutant is a measurable variable that has deleterious effects on the water body, e.g. sedimentation/siltation, total phosphorus, ammonia (un-ionized), methylmercury, dissolved oxygen, pH, etc. For example, the pollution "alteration in stream-side or littoral vegetative covers" is a category that in and of itself may not directly attribute to impairment or water quality degradation. The loss of this vegetative integrity will no longer be a buffer to control excess sedimentation/siltation or nutrients (pollutants) from entering waterbodies which will subsequently affect biological communities, water quality, in-stream habitat and loss of shading that ameliorates water temperature. The previous example (alteration in stream-side or littoral vegetative covers) will serve to clarify why habitat assessment (streams) is also considered pollution. Those pollutants such as sedimentation/siltation, nutrients, or water temperature typically are listed along those nonsupporting segments, directly elucidating the pollutant(s) to be addressed to restore full support of the use to that water body/segment. Habitat assessment (streams) is the most commonly reported pollution for streams not supporting aquatic life use. It should be noted that streams with this identified pollution make their way on the 303(d)-list since it is almost never without associated pollutants such as sedimentation/siltation (this is a primary function of riparian vegetation: to abate excess sedimentation, remove excess nutrients and ameliorate water

Table 3.2-2. List of impairments or causes considered pollution by the KDOW (ADB numerical codes listed).

(84) Alteration in stream-side or littoral vegetative covers
(85) Alterations in wetland habitats
(105) Benthic-macroinvertebrate bioassessment (streams)
(150) Chlorophyll *a*
(161) Combination benthic/fishes bioassessments (streams)
(162) Combined biota/habitat bioassessments (streams)
(181) Debris/floatable/trash
(205) Dissolved oxygen saturation
(218) Eurasian water milfoil, *Myriophyllum spicatum*
(227) Excess algal growth
(228) Fish-passage barrier
(229) Fish kills
(230) Fishes bioassessment (streams)
(243) Habitat assessment (streams)
(266) Lake bioassessment
(270) Low flow alterations
(312) Non-native aquatic plants
(313) Non-native fish, shellfish, or zooplankton
(316) Odor threshold number
(319) Other flow regime alterations
(331) Particle distribution (embeddedness)
(336) Periphyton (Aufwuchs) indicator bioassessments (stream)
(368) Secchi disk transparency
(387) Suspended algae
(402) Total organic carbon
(412) Trophic State Index
(422) Zebra mussels, *Dreissena polymorpha*
(445) Abnormal fish deformities, erosions, lesions, tumors
(446) Habitat assessment (lakes)
(450) High flow regime
(459) Taste and odor
(460) Aquatic plants – native
(465) Fish advisory – no restriction
(471) Bottom deposits
(477) Bacterial slimes
(478) Aquatic plants (macrophytes)
(479) Aquatic algae

temperature). In the uncommon circumstance where "habitat assessment (streams)" is the only reported "impairment," then it is recognized that pollutants have not been observed or measured that contribute to the biological indicator community(s) not supporting, so the impairment, "impairment unknown", will be listed which, as a pollutant, will put it on the 303(d)-list. In these instances more intensive investigation is needed to determine individual pollutants than the initial biosurvey provided. In this example the water body/segment will be categorized in category 5 (303(d)-list) with the impairment, habitat assessment (streams), included in the list of impairments. To restore aquatic life use to full support, pollution (e.g. riparian vegetative zone) must be addressed along with addressing the pollutants (e.g. sedimentation/siltation) in a TMDL.

Another group of impairments considered pollution that may be recognized in stream biosurveys are those indicating non-native aquatic plants, non-native fish, shellfish, or zooplankton and the zebra mussel, *Dreisenna polymorpha*. While these conditions are undesirable and can have a negative impact on the native plant or animal communities in a water body or segment, these non-natives, almost without exception, have been introduced accidentally or intentionally via commerce or recreation (ship ballasts, boating (carrying zebra mussels or exotic plants from one area to another), aquarists, sportspersons (non-native trout), etc.). To write a TMDL to eliminate these non-natives would often be more damaging to the environment (e.g. biocides or mechanical removal) than leaving them in place; they are so widespread and prevalent where they occur it is hardly feasible. For example, if the non-native carp, *Cyprinus carpio*, found in many perennial streams and reservoirs in the state, was considered a pollutant rather than pollution, a TMDL would be required to address this in thousands of stream miles and reservoir acres. These examples are instances where the occurrence of those impairments considered pollution (non-natives) alone will not result in a category 5 listing, rather a category 2 if all biological community metrics indicate the aquatic life use is supporting.

Those impairments that may be indicators of nonsupport for aquatic life use, but are not pollutants themselves: 1) benthic macroinvertebrate bioassessment (streams); 2) chlorophyll *a*; 3) combination benthic/fishes bioassessment; 4) combined biota/habitat bioassessments (streams); 5) dissolved oxygen saturation; 6) excess algal growth; 7) fishes bioassessment (streams); 8) lake bioassessment; 9) periphyton (aufwuchs) indicator bioassessments (stream); 10) Secchi disk transparency; 11) suspended algae; 12) trophic state index; and 13) fish advisory – no restriction, are considered pollution. The KDOW uses macroinvertebrates and fishes routinely to make aquatic life use support determinations in streams. These biological indicators are the data that go into KDOW's multimetric indices and are assigned various tolerance levels based on taxon, percent dominance of tolerant taxa, percent intolerant taxa, such as Ephemeroptera (mayflies), feeding strategy (e.g. filterers or scrapers), as well as watershed drainage area which naturally influences the populations within each community of indicators. While these biological communities are robust environmental indicators of water quality and integrity of habitat, they are not pollutants, but a manifestation of those tolerant organisms exploiting conditions that eliminate intolerant populations via pollutant(s). Through physicochemical data taken at time of biosurveys and habitat (in-stream habitat and land use observations), at least the most detrimental pollutants are usually recognized as contributors to the degraded biological community(s). Most stream miles in Kentucky not supporting aquatic life use are impaired primarily by the pollutants sedimentation/ siltation (habitat smothering), nutrient enrichment, or salinity/TDS/chlorides, in addition to pollution in the form of habitat alterations (often riparian zone related). All these pollutants affect habitat or physicochemical variables which manifest in the biological community structure. In cases where no pollutants are recognized, "impairment unknown" is listed, which places the water body/segment in category 5, needing a TMDL.

The total number of assessed stream miles was determined by adding the miles represented by the site-specific random survey (not extrapolated data) and the miles assessed by targeted monitoring. In other words, miles assessed by targeted monitoring in wadeable streams were included in miles assessed by the random survey (first-fifth order). However, results were also presented separately for targeted and random total miles.

3.2.1 Aquatic Life Use

The water quality and biological data provided by the programs described in the preceding pages were used to assess use support in rivers and streams. Table 3.2.1-1 shows the designated uses of Kentucky waters, and the indicators employed to make those support/nonsupport determinations. Given the comprehensive suite of parameters sampled by KDOW for many stream assessments, both biological and physicochemical, a determination can typically be made as to the cause(s) and source(s) of pollutant/ pollution affecting the resource. Further study during TMDL development will lead to specific definition of causes and sources. Data were categorized as "monitored" or "evaluated." Monitored data were derived from site-specific surveys; generally no more than five years old. Typically, data older than five years were considered "evaluated" (assessment code 150), but this did not change the assessment category to which a water body and/or segment had been assigned unless there were more recent "monitored" data. In some instances where conditions were believed to have remained mostly unchanged, monitored data collected prior to 1995 were still considered valid and waters described by these data were categorized as monitored. Additionally, data from the random survey network were used. Approximately 17,500 stream miles had been monitored in the commonwealth by targeted efforts through March 2005. Like the targeted stations, each random survey station was used to assess a limited reach of stream around the sample point. Few evaluated waters remain in the assessment database. Although all efforts in the watershed initiative were to gather defensible, monitored data, there were some monitoring data more than five years old, strong anecdotal information, and extrapolation of discharge data that resulted in evaluated assessments.

Water Quality Data. Chemical data collected by KDOW and others were assessed according to EPA guidance (U.S. EPA 1997). Water quality data were compared to criteria contained in Kentucky Water Quality Regulations (401 KAR 5:031). The segment fully supported warmwater aquatic habitat (WAH) use when criteria for dissolved oxygen, un-ionized ammonia, temperature and pH were not met in 10 percent or less of the samples collected (April 2001 - March 2005 for the ambient stations and 12 months for the targeted rotating watershed cycle stations). Impaired, partial support was

Table 3.2.1-1. Designated uses in Kentucky waters and the indicators used to assess level of support.

Indicators	USES			
	Aquatic Life	Recreation	Fish Consumption	[a]Drinking Water
Core Indicators	<u>Stream</u>: 1-3 biological communities: macroinvertebrates, diatoms and fishes Dissolved oxygen Temperature pH Specific conductance <u>Lake/Reservoir:</u> Dissolved oxygen Temperature pH Specific conductance Fish kills	<u>Stream:</u> Pathogen indicators: fecal coliform; *E. coli* pH <u>Lakes/Reservoir:</u> Pathogen indicators: fecal coliform or *E. coli* pH	Mercury PCBs	Inorganic chemicals Organic chemicals Pathogen indicators: fecal coliform, *E. coli*
Supplemental Indicators	Chlorophyll-*a* Trophic State Index (TSI) Secchi depth Indicator health (vigor) Water chemistry Sediments	Nuisance macrophytes Nuisance macroscopic algal growth Nuisance algal blooms Suspended sediment	Other chemicals of concern found in water quality standards	Odor Taste Treatment problems caused by poor water quality

[a]All core indicators are based on "at the tap" MORs received from PWS

indicated if any one criterion for these parameters was not met in 11-25 percent of the samples. A segment was determined to be impaired, not supporting, if any one of these criteria was not met in more than 25 percent of the samples.

Data for mercury, cadmium, copper, iron, lead and zinc were analyzed for exceedences of acute criteria listed in state water quality standards regulations using at least three years of data. The segment fully supported WAH use if all criteria were met at stations with quarterly or less frequent sampling, or if only one exceedence occurred at stations with monthly sampling. Impaired, partial support was indicated if any one criterion was not met more than once but in less than 10 percent of the samples. The segment was determined to be impaired, not supporting, if criteria were exceeded in greater than 10 percent of the samples. The assessment criteria were closely linked to the way state and federal water quality criteria were developed. Aquatic life was considered protected if, on average, the acute criteria were not exceeded more than once every three years. Data were also compared to chronic criteria. Observations that equaled or were only slightly greater than chronic criteria were not considered to exceed water quality standards. Toxic criteria were assessed based on 12 monthly samples at the rotating watershed ambient water quality network and, generally, 48 samples from the primary ambient water quality network. The segment fully supported WAH use if all criteria were met or exceeded only once. Impaired, partial support was assessed if any criterion was not met more than once, but in less than 10 percent of samples. The segment was determined to be impaired, not supporting, if criteria were exceeded in greater than 10 percent of samples.

Biological Data (streams). Decisions about use attainment for aquatic life are primarily made using biological data obtained from monitoring programs within the KDOW and other agencies. There are a number of reasons biological data are important in making level of support decisions for aquatic life use. Biological communities (indicators) integrate their environment, and thus serve as good monitors of the conditions (physical, chemical, and habitat) they live in. The core indicators for bioassessment are outlined in Table 3.2.1-2. Level of use support is dependent on the indicator community(s) health and integrity, with supplemental physicochemical and habitat data. These results are applied for assessment purposes as outlined in Table 3.2.1-2.

Macroinvertebrates have been used extensively in water quality monitoring and impact assessment since the early 1900s. Today, macroinvertebrates are used throughout the world in water quality assessment as environmental indicators of biological integrity, to describe water quality conditions or health of the aquatic ecosystem, and to identify causes (pollutants) of impairment. This indicator community is relatively sedentary, spending a significant portion of its life cycle in the aquatic environment, various populations of a community are dependent on multiple habitats in the water column, occupy multiple consumer levels throughout the food web (herbivores, omnivores, and carnivores), and significantly, many sensitive taxa (benthos) live in or on the sediments of streams. These characteristics and habits make macroinvertebrates a key indicator

Table 3.2.1-2. Biological criteria for assessment of warm water aquatic habitat (streams) use support[a].

Indicator	Fully Supporting	Partial Support	Nonsupport
Algae	Diatom Bioassessment Index (DBI) Classification of excellent or good; biomass similar to reference/control or STORET mean.	DBI classification of fair; increased biomass (if nutrient enriched) of filamentous green algae.	DBI classification of poor; biomass very low (toxicity), or very high (organic enrichment).
Macroinvertebrates	Macroinvertebrate Bioassessment Index (MBI) excellent or good, high Ephemeroptera, Plecoptera and Trichoptera (EPT) sensitive species present.	MBI classification of fair, EPT lower than expected in relation to available habitat, reduction in RA of sensitive taxa. Some alterations of functional groups evident.	MBI classification of poor; EPT low, (total number of individuals) TNI of tolerant taxa very high. Most functional groups missing from community.
Fishes	Index of Biotic Integrity (IBI) excellent or good; presence of rare, endangered or species of special concern.	IBI fair.	IBI poor, very poor, or no fish.

[a]Acronyms used in this table: EPT= Ephemeroptera, Plecoptera, Trichoptera; RA= Relative Abundance; TNI= Total Number of Individuals

group of their environment. KDOW defines benthic macroinvertebrates as organisms large enough to be seen by the unaided eye, can be retained by a U.S. Standard Number 30 sieve (28 mesh/inch, 600 µm openings), and live at least part of their life cycle within or upon available substrates of a water body. In addition to determining use support level, biomonitoring will identify those Exceptional Waters (401 KAR 5:030) (those waters that are among the most biologically diverse and represent biological integrity to a high degree in a given bioregion) occurring across the commonwealth.

The evaluation of fish community structure is an important component of biological monitoring for providing reliable assessments for the CWA, Section 305(b). The primary goal of evaluating fish community structure is to ensure accurate assessments for 305(b) by using the Kentucky Index of Biotic Integrity (KIBI) of the community present. Advantages of using fish as biological indicators include their widespread distribution, utilization of a variety of trophic levels, stable populations during summer months, and the availability of extensive life history information (Karr et al. 1986).

Algae (primarily diatoms) are indicators of water quality, particularly as it relates to trophic (fertility) status and toxicity conditions. The Diatom Bioassessment Index (DBI) is calculated when this indicator community is monitored. This indicator group is critical to the food web of streams, beginning the process of primary production through photosynthesis.

Federally Threatened and Endangered Species. Waters with federally threatened or endangered species in November 1975 have an existing "use" of Outstanding State Resource Water and the loss or significant decline of one of these populations constitutes an impairment of use.

Lakes/Reservoirs. Lakes/reservoirs were assessed for aquatic life by measuring several physicochemical indicators, in addition to reported fish kills. The lack of a direct biological indicator is primarily due to most of this resource being manmade, thus supporting altered and unnatural biological communities that are composed almost exclusively of tolerant species (e.g. Tubificidae, *Chironomus* spp., *Chaoborus* spp., *Glyptotendipes* spp., etc.) that are capable of exploiting this naturally low DO-stressed environment. Thus, core and supplemental indicators (Table 3.2.1-1) are of utmost importance to assure water quality conditions are suitable for supporting primarily sportfish, and associated prey fishes; these populations are the primary concern for aquatic life use being met or not in created environments. Table 3.2.1-3 outlines the criteria used in making use assessment decisions.

Trophic status was assessed in lakes/reservoirs using the Carlson Trophic State Index (TSI) for chlorophyll-*a*. This method was convenient because it allows lakes to be ranked numerically according to increasing productivity, and it also provides for a distinction between oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic lakes. The growing season (March – October) average TSI value was used to rank each lake. Areas of lakes that exhibited trophic gradients or embayment differences often were analyzed separately.

Table 3.2.1-3. Criteria for lake/reservoir use support classification.

Category	Fish Consumption	Warmwater Aquatic Habitat	Secondary Contact Recreation	Domestic Supply
Not Supporting:	(Pollutant specific)	(At least two of the following criteria)	(At least one of the following criteria)	(At least one of the following criteria)
	Methylmercury >1.00 ppm (fish tissue)	Fish kills caused by poor water quality	Widespread excess macrophyte/macro-scopic algal growth	Chronic taste and odor complaints caused by algae
	PCBs >1.9 ppm (fish tissue)	Severe hypolimnetic (deepest layer in a thermally stratified lake or reservoir) oxygen depletion	Chronic nuisance algal blooms	Chronic treatment problems caused by poor water quality
		Dissolved oxygen average less than 4 mg/L in the epilimnion (upper most layer of water in a thermally stratified lake or reservoir)		Exceeds drinking water MCL
Partially Supporting: (At least one of the following criteria)	Methylmercury >0.3 – 1.00 ppm (fish tissue)	Dissolved oxygen average less than 5 mg/L in the epilimnion	Localized or seasonally excessive macrophyte/macroscopic algal growth	Occasional taste and odor complaints caused by algae
	PCBs >0.2 ppm – 1.9 ppm (fish tissue)	Severe hypolimnetic oxygen depletion	Occasional nuisance algal blooms	Occasional treatment problems caused by poor water quality
		Other specific cause (e.g. low pH)	High suspended sediment concentrations during the recreation season	
Fully Supporting:	Methylmercury <0.3 ppm and PCBs <0.2 ppm	None of the above	None of the above	None of the above

3.2.2 Primary Contact Recreation Use Support

Fecal coliform or *Escherichia coli* and pH data were used to indicate the degree of support for primary contact recreation (PCR) (swimming) use. PCR assessment was based on six monthly grab samples collected during the recreation season of May – October. The use fully supported if the fecal coliform bacteria criterion of >400 colonies per 100 mL (>240 colonies per 100 mL for *E. coli*) was not met in less than 20 percent of samples; it was determined to be impaired, partial support if either criterion was not met in 25-33 percent of samples; and impaired, nonsupport, if either criterion was not met in >33 percent of samples. Secondary contact recreation (SCR) was also assessed following the same method using fecal coliform data at the concentration of >2000 colonies per 100 mL. Streams with pH <6.0 SU or >9.0 SU were considered full support if this criterion was exceeded once, but in less than 10 percent of samples collected in the recreation season; impaired, partial support if the standard was exceeded more than once, but in less than 10 percent of the samples during the recreation season; and impaired, nonsupport if the criterion was exceeded in more than 10 percent of samples during the recreation season.

3.2.3 Other Data Sources

Discharge Monitoring Reports (DMRs). Discharge monitoring report (DMR) data, collected by Kentucky Pollutant Discharge Elimination System (KPDES) permit holders, were assessed through KDOW's permit compliance database. Depending on the relative sizes of the wastewater discharge, the receiving stream and the severity of the permit exceedences, it sometimes was possible to assess in-stream uses as nonsupporting either AL or PCR. Because in-stream data were usually not collected, stream assessments based only on DMR data were considered evaluated, not monitored, and these segments were assigned to category 5B.

Corps of Engineers (COE) Reservoir Projects. Dam projects on major streams in Kentucky were monitored with the cooperation of the COE. During the Interagency Monitoring and Planning Meeting those reservoirs in the BMU of focus were identified and a cooperative effort between KDOW and COE resulted. Reservoir water quality variables were monitored over the growing season (March – October) and major in-flow and out-flow tributaries of these reservoirs were monitored for water quality. Aquatic life use support level was determined using these monitored data for reservoirs and monitored tributaries. The Louisville COE District covers both the Kentucky River and Salt - Licking Rivers BMUs reported on in this IR.

3.2.3 Fish Consumption Use Support

Fish consumption, in conjunction with aquatic life use, assesses attainment of the fishable goal of the Clean Water Act. Assessment of the fishable goal was separated into these two categories in 1992 because the fish consumption advisory does not preclude attainment of the aquatic life use and vice versa. Separating fish consumption and aquatic life use support gave a clearer picture of actual water quality conditions.

Kentucky revised its methodology for issuing fish consumption advisories in 1998 to a risk-based approach patterned after the Great Lakes Initiative. The risk-based approach generally was more conservative than the Food and Drug Administration (FDA) action levels that were used previously. For example, the FDA action level for mercury was 1.0 mg/Kg, but the risk-based number for issuing an advisory was as low as 0.12 mg/Kg. As a result of this change in methodology, a statewide advisory was issued in April 2000 for children under six and women of childbearing age to not consume more than one meal per week of any fish from Kentucky waters because of mercury. However, EPA (2001a) issued a draft mercury water quality criterion expressed as a methylmercury concentration in fish tissue of 0.3 mg/Kg. Therefore, for purposes of 305(b) reporting, waters were not considered impaired unless fish exhibited mercury tissue concentrations of at least 0.3 mg/Kg. In other words, the fish tissue concentration triggering the statewide advisory (0.12 mg/Kg) was considered more stringent than water quality standards.

Other than the statewide advisory for mercury explained above, the following criteria were used to assess support for the fish consumption use:

- Fully supporting- no fish consumption restrictions or bans in effect; highest species average concentration ≤ 0.3 mg/Kg
- Impaired: Partial support- “restricted consumption”-fish consumption advisory in effect for the general population or a subpopulation that potentially could be at a greater cancer risk (e.g. pregnant women, children); highest species average concentration > 0.3 mg/Kg – 1.0

mg/Kg. Restricted consumption was defined as limits on the number of meals consumed per unit time for one or more fish species

- Impaired: Not supporting- “no consumption” -fish advisory or ban in effect for the general population or a subpopulation that potentially could be at greater risk, for one or more fish species, or a commercial fishing ban in effect; highest species average concentration > 1.0 mg/Kg.

3.2.4 Drinking Water Supply

Drinking water use support was determined in several ways. First, compliance with maximum contaminant levels (MCLs) in finished water was determined by the annual average of quarterly samples. These MCL data were gleaned from monthly operating reports (MORs) submitted to KDOW, Drinking Water Branch, from treatment facilities. Drinking water use assessments in reservoirs were supplemented by surveys of drinking water operators on any taste and odor problems and use of biocides (Table 3.2.1-1). The routine application of a biocide, or use of carbon filtration, were reasons for assessing a source of water as not fully supporting the domestic water supply use. In-stream water quality data generally were not available to assess drinking water use.

3.2.5 Impairments and Sources

Impairments (pollutants and pollution) and sources were categorized according to EPA guidance. Impairments for primary contact recreation, fish consumption, and water supply usually were easily identified. The majority of segment/waterbodies not supporting aquatic life use were determined by biological monitoring supplemented by monitoring of select physicochemical parameters. Causes and sources of impairment may not be evident in the field and there may be other pollutants contributing to use impairment that were not listed. Once on the 303(d) list, subsequent intensive monitoring and watershed reconnaissance of land uses will more fully identify causes and sources of impairments.

3.2.6 Determination of Assessment Segments

Once an assessment is made on a water body, an appropriate segment or portion of the water body representative of the monitored area is determined. Part of this determination is based on the type of monitoring (e.g. physicochemical, biological, bacteriological, fish tissue, or lake/reservoir).

Aquatic Life, Recreation and Fish Consumption Uses. Monitoring for these uses occurs throughout the state at the Primary Ambient Water Quality Stations (Primary Network) and in the Rotating Watershed Stations particular to the BMU cycle phase. Since the Primary Network stations are located on large streams and rivers, these assessment segments are taken downstream and upstream of significant streams entering the monitored stream. Significance of tributaries is based on the watershed area and relative volume. Another important factor considered in defining segments is significant changes in land use from along the reach of stream sampled, such as leaving a contiguous forested area and entering a non-forested area with fragmented riparian vegetative zone. Since many of KDOW's PCR-SCR (recreation) monitoring locations are associated with the ambient water quality network, the same rationale is used to define these segments and typically is the same as the defined segment for the accompanying aquatic life use assessment.

Those waters assessed for aquatic life use having biological community data often will be of shorter segment reach since these indicators are typically more responsive to subtle changes in water quality as they integrate these conditions over a relatively long time. Also, the habitat conditions along the corridor being assessed are paid close attention to for the same reasons as physicochemical considerations for biological communities. Typically the smaller the watershed, a proportionately greater segment will be defined since the conditions and influences from surrounding land use are similar and localized in those streams. In larger watersheds, typically greater than five square miles, proportionately smaller assessment segments are defined due to the increased potential of sources of pollutants and habitat influences. These segments are defined by upstream and downstream tributaries judged to be of significant drainage area to the receiving stream.

Fish consumption segments are defined in a similar method as those reaches assessed using only physicochemical, or bacteria data. Many fish species are relatively long ranging, and that factor has significant consideration in defining segments. Also, with the plethora of sources, and the fact that much of the mercury in waters comes via atmospheric deposition, relatively long reaches are often defined when making these assessments. However, significant tributaries are often used to make the upstream and downstream termini, with less consideration given to habitat for the reasons given above.

Drinking Water. Since this use was assessed using finished water data supplied by Public Water Systems (PWS), the assessment segments were usually conservative when applied to the source water. The assessment segments were typically taken from the point of withdrawal and extended upstream one mile. A few exceptions to that rule occurred when multiple uses were assessed (e.g. fish tissue, aquatic life) in the same general area of PWS withdrawal points. Those segments were usually longer (see section above on these use assessment segments) in order to accommodate those other uses that overlapped the PWS withdrawal point. In the case of reservoirs, the assessment was applied to the water body.

3.3 Use Assessment Results: Focus on the Kentucky and Salt - Licking Rivers BMUs

Section Overview. This section of the IR presents assessment results primarily on two BMUs, the Kentucky River and Salt-Licking rivers, which were monitored in 2003 and 2004, respectively. However, a statewide summary updating all waters and segments assessed prior to 2003 was incorporated into use support statistics (10,483.10 miles assessed, or 11.5 percent of stream miles at a resolution of 1:24,000) and is presented in the following subsection (Tables 3.3.1-1 and 3.3.1-2). Appendix A contains a table with all assessed waters and the support level per use assessed. Trend analyses on Primary Water Quality Network stations were performed in 2005, and results of these analyses at stations showing trends of various water quality variables follow. Targeted and random biosurvey results of streams were presented with particular focus on the two BMUs of this reporting cycle. The KDOW continues to census lakes and reservoirs in the commonwealth, and trend information on these reservoirs is presented following 25 years of data related to trophic state analyses. The COE reservoirs were monitored by that agency, and the results of those data and trophic status of trends were also provided in the lakes section.

3.3.1 Statewide Assessment Results (Use Support)

Targeted Monitoring: Streams and Rivers. For this monitoring and reporting period (Kentucky and Salt-Licking BMUs) there were 281 stream segments representing 1,575 miles assessed during the monitoring years of 2003-2004. These data represent years one and two of the second five-year intensive monitoring effort based on rotating BMUs. Probabilistic monitoring results are included in the targeted monitoring statistics since that method is used for both specific stream reach assessments as well as extrapolation of data for aquatic life use support in a given BMU. Total miles of streams and segments that are fully supporting assessed uses (Categories 1, 2 which includes 2B) are 4,946; whereas those streams and rivers with segments not fully supporting assessed uses (Categories 4A, 4B, 4C, 5A and 5B) total 5,857 miles (Table 3.3.1-1). Category 3 represents water body segments that have at least one use assessed, but not all designated uses were assessed. This table reports results based on the lowest assessed use much like an overall assessment where if one use is not fully supporting than by default the entire stream mileage assessed is reported in Category 5. The uses most commonly assessed were aquatic life, drinking water (where it is applicable) and primary and secondary contact recreation. There were 10,310 total stream miles (59 percent) fully supporting a designated use (Table 3.3.1-2). (This where any one stream segment fully supported more than one use.)

Aquatic Life Use. Nonsupport of warm water and cold water aquatic habitat uses continues to represent the greatest number of stream miles, with 3,741 combined miles (Table 3.3.1-2) representing 39.2 percent of stream miles assessed. However, more miles of streams were assessed for this designated use, and it has the highest percentage of support level by percent, 60.8. Compared to the 2004 305(b) report, stream miles that do not support aquatic life use have increased by 746 miles. The number of stream miles fully supporting aquatic life use has decreased 79 miles as compared to 2004 305(b) data.

Fish Consumption. The percentage of stream miles that fail to support a use is highest for fish consumption at 58.1 percent of stream miles assessed (Table 3.3.1-2). This is an increase of more than 10 percent compared to the 48 percent seen in 2004

Table 3.3.1-1. Size of surface waters assigned to reporting categories[1] for Kentucky.

Water Body Type	Category									Total in State	Total Assessed
	1	2	2B[2]	3[3]	4A	4B	4C	5	5B		
RIVER (MILES)	82.00	4,363.81	499.80	231.60	295.33	0.00	0.00	5,458.72	51.64	10,483.10	1,858
FRESHWATER RESERVOIR (ACRES)	0.00	120,779.35	1471.00	430,186.8	0.00	0.00	232.00	97,970.00	0.00	218,981.35	109
FRESHWATER LAKE (ACRES)	0.00	342.00	0.00	1,677.00	0.00	0.00	0.00	229.00	0.00	571.00	12
POND (ACRES)	0.00	3.30	0.00	14.4	0.00	0.00	0.00	1.50	0.00	4.80	2
SPRING (MILES)	0.00	0.03	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.03	1
FRESHWATER WETLANDS (ACRES)	0.00	0.00	0.00	324,000.00	0.00	0.00	0.00	0.00	0.00	324,000.00	0

[1]Refer to Table 3.2-1 on page 47 for a definition of each reporting category
[2]"Total in State" sum does not include miles in this subcategory as these miles may also occur in other categories (i.e. 1, 2, 4B, 5 and 5B)
[3]Category sum is stream miles that do not have any designated uses assessed in another category

305(b) data of 48.0 percent. Besides the statewide fish consumption advisory for mercury, longstanding fish consumption advisories remain in effect in several rivers and streams throughout the commonwealth. The primary source of mercury entering waters is thought to be via air emissions. Because of interstate issues and complexity of identifying all sources of mercury, EPA is conducting national studies and will likely be involved in eventual efforts to calculate TMDLs and reduce mercury inputs by setting new mercury limits.

Polychlorinated biphenyls (PCBs) are man-made chemical products that are similar in structure. These chemicals are toxic and persistent in the environment. In 1976 Congress passed legislation that prohibits the manufacture, process and distribution in commerce of PCBs. Polychlorinated biphenyls contaminate fish flesh in four streams totaling 124.9 miles from the streams and segments listed below:

- Mud River from Hancock Lake Dam to mouth in Logan, Butler and Muhlenberg counties
- Town Branch Creek, headwaters to mouth in Logan, Butler and Muhlenberg counties
- West Fork Drakes Creek, dam at City of Franklin to mouth in Simpson and Warren counties
- Little Bayou Creek from headwaters to mouth in McCracken County

Primary (Swimming) Contact Recreation Use. The percentage of stream miles that do not support primary contact recreation (PCR) is now the second highest of all uses at 56.9 percent (Table 3.3.1-2). This represents an 8.3 percent increase in number of miles assessed that are not attaining support for this designated use compared to 2004 305(b) results. This designated use also represents the second highest number of stream miles not supporting with 2,147.3 miles (Table 3.3.1-2). Note that this designated use applies during the recreation months of May through October.

There continue to be a number of swimming advisories on segments of streams and rivers in Kentucky. Below are the waterbodies and segments where advisories exist. Fish consumption advisories on the Ohio River may be found in Section 3.3.3.

Table 3.3.1-2. Individual designated use support summary for streams and rivers in Kentucky (miles).

Designated Use	Total in State	Total Assessed	Supporting-Attaining WQ Standards	Supporting-Attaining WQ Standards but Threatened	Not Supporting-Not Attaining WQ Standards	Not Assessed
Warm Water Aquatic Habitat	10,153.2	9,223.0	5,507.8	0.0	3,715.2	930.3
Cold Water Aquatic Habitat	329.9	326.9	301.3	0.0	25.6	3.0
Fish Consumption	10,483.1	1,706.9	715.6	0.0	991.3	8,776.3
Primary Contact Recreation Water	10,483.1	3,773.4	1,626.1	0.0	2,147.3	6,709.8
Secondary Contact Recreation Water	10,483.1	1,089.2	800.4	0.0	288.8	9,393.9
Drinking Water	1,438.4	1,359.0	1,359.0	0.0	0.0	79.4

Upper Cumberland River Basin

- Cumberland River from SR 2014 to Pineville Hwy 66 and from SR 219 to Harlan
- Martins Fork from Harlan to Cawood Water Plant
- Catrons Creek
- Clover Fork
- Straight Creek
- Poor Fork from Harlan to Looney Creek
- Looney Creek from mouth to Lynch Water Plant Bridge

Lower Licking River Basin

- Banklick Creek
- Threemile Creek

North Fork Kentucky River Watershed

- North Fork Kentucky River upstream of Chavies to source (headwaters)

Secondary Contact Recreation Use. Secondary contact recreation designated use applies year-round and criteria for support of this use are based on fecal coliform standard of 2000 colonies/mL in streams, lakes and reservoirs. There are 288.8 miles not supporting this use out of 1089.23 miles of streams assessed. This represents 26.5 percent of assessed waters that do not support this designated use. No comparison for prior years can be made as this 305(b) cycle represents the first time this use has been assessed in flowing waters. In streams and rivers secondary contact recreation standard is applied to protect people from incidental water contact or only partial body emersion that may occur in such activities as fishing and boating.

Drinking Water Use. Drinking water standards apply to the source water at point of intake. Drinking water use support was assessed by review of the average quarterly results for contaminants as reported in MORs (monthly operating reports that are required by the Safe Drinking Water Act). The average annual result of these quarterly data is determined for compliance purposes. The MCLs (maximum contaminant levels) are based on concentration of each contaminant in the finished product distributed for public consumption. Of those streams assessed, all were fully supporting drinking (domestic) water use.

Probability Monitoring: Aquatic Life Use. The random design biosurvey effort has been implemented through a complete five-year cycle in the state. Data results on a statewide basis are presented in Table 3.3.1-3 covering cycle one from 1998-2003. These assessment data are exclusive of targeted (site-specific) monitoring, unlike the targeted results presented in Table 3.3.1-2 that incorporate both methodologies. These data indicate 42 percent of stream miles (1^{st} - 5^{th} Strahler order) were fully supporting aquatic life use while 58 percent of statewide stream miles were not fully supporting that use (Table 3.3.1-3). This was in contrast to targeted results indicating 60.8 percent fully supporting and approximately 40 percent not supporting aquatic life use. There are some reasons for this apparent discrepancy. Targeted monitoring has an inherent bias in monitoring strategy. For example, one of the targets is the reference reach program. This is a deliberate and necessary effort to find the best stream reaches in the commonwealth. These reaches can be afforded additional protection through Kentucky's water quality standards. Also, the WBMP monitors 4^{th} - 6^{th} order stream reaches on a cyclical schedule. These ambient locations typically support aquatic life use. The nature of random monitoring lends itself to integrating ambient conditions in a basin or bioregion since there is no bias of sample locations.

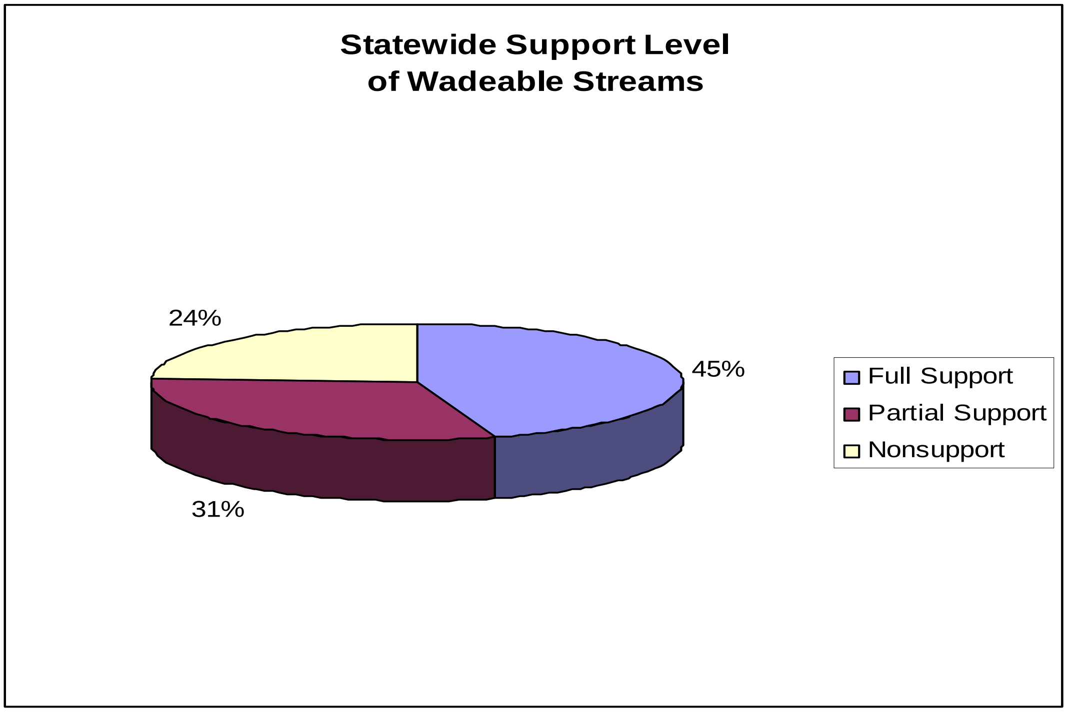
Table 3.3.1-3. Use support summary of Kentucky wadeable rivers and streams (miles), probabilistic monitoring (2000 – 2004).

	Total Assessed	Fully Supporting	Partially Supporting	Not Supporting
Aquatic Life	52,580.6	23,814.3 (45.3%)	16,056.6 (30.5%)	12,709.7 (24.2%)

A simple question has been asked throughout the 35-year history of the Clean Water Act: "What is the condition (health) of the nation's waters?" Various studies have been undertaken to determine an answer to that question. These findings concluded that while agencies have been good at collecting data about site-specific conditions of states' waters, there exist no data to determine the overall condition and trend of the waters on a national scale. To answer that question and related questions (Are water quality (fishable and swimmable) conditions improving? Are there new issues and threats related to aquatic ecosystem health or any successes?) to help citizens determine if more money and resources need to go toward water quality issues, or if the billions of dollars being spent to curb and control pollution is simply not working, a national study was undertaken.

To begin to answer this complex question it was determined that a statistically valid random biosurvey of the nation's streams would be necessary. The EPA oversaw the development and implementation of a random design study of the nation's streams and was able to make substantive decisions concerning the ecological condition of our waters. The random survey may be likened to a political poll in which a random sample of likely, eligible voters in a given congressional district, or nationally in a presidential race, is polled to discover the likelihood of a particular candidate to win election. In the national survey, all eligible wadeable streams of Strahler order 1-4 in similar ecoregions, or group of similar ecoregions based on biological similarities known as bioregions, define the population from which to randomly select representative stream segments in order to draw scientifically sound conclusions on the findings of those data. The national study segregated the lower 48 states into three broad regions defined as the West, Eastern

Figure 3.3.1-1. Statewide proportions of aquatic life use support in Kentucky based on probability biosurveys. Pie chart represents the entire defined stream population (Strahler order 1 – 5) for the commonwealth.



Highlands and Lowlands (Wadeable Streams Assessment, USEPA, 2006). When grouped together, only 28 percent of the nation's wadeable streams were in good condition (conditions similar to the least-disturbed reference streams in each ecoregion), and 42 percent were in the category "most disturbed." Approximately 75 percent of Kentucky is in the Eastern Highlands with the remainder (western Kentucky) in the Lowlands region.

The Eastern Highlands region had only 18 percent of streams in good condition and 52 percent were found to be in poor condition. This region had the smallest percent of regional stream miles in good condition. The Lowlands had 29 percent of regional stream miles in good condition, and 40 percent were in poor condition. In both cases the remaining percent are primarily streams represented by intermediate conditions.

Based on the results of KDOW's probability monitoring program, Kentucky's full support level of streams on a statewide basis (42 percent) is in contrast to streams in the same region in the national study. Looking only at the Eastern Highlands, the condition of the commonwealth's streams (33 percent) compare favorably with the multi-state region in which only 18 percent were in good condition and nationally where only 28 percent of streams were found to be in good condition.

Impairments (Causes) and Sources Related to Nonsupport of Uses. The leading impairments or causes for designated-use nonsupport of Kentucky streams and rivers are sedimentation, fecal coliform (pathogens), habitat (streams), polychlorinated biphenyls (PCBs) and nutrient/eutrophication biological indicators (Table 3.3.1-4). The leading sources of these impairments are agriculture, mining, urban or municipal and habitat related (other than hydromodifications), and a significant percentage of impairments have sources listed as unknown (Table 3.3.1-5). In this report, agriculture displaces "source unknown" as the leading source of pollution and pollutants in the commonwealth, with approximately 2,850 miles of streams impacted. This is the result of grouping the subcategories under broad categories to better reflect those significant sources that contribute to impairment of streams in the state.

Individual use support by major river basin is shown in Table 3.3.1-6. This overview of the commonwealth's major river basins shows the greatest percentage of river miles not supporting aquatic life use is found in the Mississippi River Basin. The Big Sandy River Basin had the second greatest percentage of nonsupporting miles followed by the Tradewater River Basin, the lower Cumberland River Basin and the Kentucky River Basin. The Kentucky, Mississippi, Big Sandy and Tradewater river basins are each in areas of intensive land use. The Big Sandy River Basin is one of the most intensive coal producing areas and the Mississippi River and Tradewater River basins are in areas of large-scale crop production. Less than one-third of the assessed stream miles in the Mississippi and Big Sandy basins and about 40 percent of assessed river miles in the Tradewater River Basin fully support aquatic life use (Figure 3.3.1-2).

The most problematic basins for primary contact recreation are in the Big Sandy (78 percent nonsupporting), upper Cumberland (78 percent nonsupporting), Tennessee (71 percent nonsupporting) and lower Cumberland (69 percent nonsupporting) (Figure 3.3.1-1). The upper Cumberland River Basin has both one of the highest percentages of aquatic life use support and lowest primary contact recreation support levels (Figure 3.3.1-1). The low support for primary contact recreation is primarily attributable to the number of straight-pipes discharging untreated sewer water into many of the streams in this basin. The associated pathogens with the straight-pipe discharge have no effect on the aquatic life as they target warm-blooded hosts. As was determined with data for the 2004 305(b) report, the Big Sandy River Basin has a high percent use of stream miles not supporting swimming, primarily because of the high percent of monitored streams where frequent observations were made of straight pipes from houses that discharged both gray and black water directly into streams.

Table 3.3.1-4. Ranking of impairments (causes) to Kentucky rivers and streams.

Impairment	Miles Impacted
1. Sedimentation	2,551.0
2. Fecal coliform (pathogens)	1,996.0
3. Habitat assessment (streams)	1,480.2
4. Polychlorinated biphenyls (PCBs)	774.0
5. Nutrient or eutrophication biological indicators	759.1
6. Impairment unknown	676.3
7. Total dissolved solids	659.9
8. Organic enrichment (sewage) biological indicators	648.1
9. Other flow regime alterations	490.8
10. Methylmercury	367.3
11. Sulfates	244.7
12. pH	223.6
13. Turbidity	218.0
14. Dioxin (including 2,3,7,8-TCDD)	194.4
15. Benthic macroinvertebrate bioassessments (streams)	147.9
16. Particle distribution (embeddedness)	100.9
17. Total phosphorus	100.9
18. Nonnative fish, shellfish or zooplankton	72.6
19. Chlorine	59.1
20. Other	53.1
21. Aquatic algae	49.0
22. Iron	48.8
23. Total suspended solids	48.1
24. Alteration in streamside or littoral vegetative covers	46.1
25. PCB in fish tissue	45.7
26. Cadmium	45.5
27. Ammonia (un-ionized)	39.2
28. Water temperature	34.7
29. Physical substrate habitat alterations	33.3
30. Chlorophyll *a*	30.4
31. Fishes bioassessment (streams)	23.1
32. Zinc	17.0
33. Nitrate + Nitrite as N	15.7
34. Copper	14.3
35. Beta particles and photon emitters	13.0
36. Gross alpha	13.0
37. Non-native aquatic plants	12.9
38. Total Kjeldahl Nitrogen (TKN)	12.3
39. Dissolved oxygen saturation	12.2
40. Total nitrogen	9.5
41. Chloride	9.3
42. Aquatic plants (macrophytes)	9.1
43. Oil and grease	8.5

Table 3.3.1-4 (cont.). Ranking of impairments (causes) to Kentucky rivers and streams.

Impairment	Miles Impacted
44. Ethylene glycol	6.8
45. Mercury	6.5
46. Dissolved oxygen	5.8
47. Total Chromium	3.9
48. Nickel	3.1

Table 3.3.1-5. Probable sources of impairment to Kentucky rivers and streams.

Source Categories	Miles Impacted
Agriculture (unspecified)	583.0
Non-irrigated crop production	514.6
Crop production (crop land or dry land)	454.0
Livestock (grazing or feeding operations)	426.8
Managed pasture grazing	386.8
Grazing in riparian or shoreline zones	170.2
Animal feeding operations (NPS)	109.8
Irrigated crop production	85.4
Rangeland grazing	55.8
Unrestricted cattle access	35.6
Permitted runoff from confined animal feeding operations (CAFOs)	15.5
Crop production with subsurface drainage	5.0
Dairies (outside milk parlor areas)	4.0
Specialty crop production	3.6
Category total (agriculture)	2,849.8
Source unknown	2,285.5
Mining	
Surface mining	738.2
Subsurface (hardrock) mining	270.8
Impacts from abandoned mine lands (inactive)	135.2
Acid mine drainage	110.3
Coal mining (surface)	105.0
Heap-leach extraction mining	87.2
Dredge mining	25.8
Coal mining (underground)	25.2
Mine tailings	11.9
Reclamation of inactive mining	8.0
Sand, gravel, rock mining or quarries	2.9
Category total	1,520.5
Urban or Municipal	
Municipal point source discharges	581.3
Unspecified urban stormwater	383.1
Urban runoff or stormwater sewers	256.2
Municipal (urbanization high density area)	89.9
Wet weather discharges (point sources and combination of stormwater, SSO or CSO)	35.0
Impervious surface or parking lot runoff	22.1
Illicit connections or hook-ups to storm sewers	10.6
Combined sewer overflows	6.3
Commercial districts (shopping or office complexes	2.6
Category total	1,386.9

Table 3.3.1-5 (cont.). Probable sources of impairment to Kentucky rivers and streams.

Source Categories	Miles Impacted
Habitat Related (other than hydromodifications)	
Loss of riparian habitat	1,059.6
Site clearance (land development or redevelopment)	177.2
Dredging (e.g. for navigation channels)	135.0
Category total	1,371.7
Residential Related	
On-site treatment systems (septic systems and similar decentralized systems, (incl. straight-pipes)	341.2
Package plant or other permitted small flows discharges	128.4
Sewage discharges in unsewered areas	50.5
Residential districts	7.5
Rural (residential areas)	4.3
Category total	531.9
Erosion and Sedimentation	
Post-development erosion and sedimentation	343.1
Sediment re-suspension (contaminated sediment)	33.9
Channel erosion or incision from upstream hydromodifications	14.6
Erosion from derelict land (barren land)	11.6
Sediment re-suspension (clean sediment)	11.6
Category total	414.8
Transportation	
Highway, road or bridge runoff (non-construction related)	262.4
Highways, roads, bridges, infrastructure (new construction)	99.7
Airports	1.6
Category total	363.6
Silviculture	
Silviculture harvesting	162.2
Silviculture activities	149.9
Permitted silvicultural activities	8.0
Silviculture reforestation	6.6
Category total	326.7
Fuel or Energy Development (other than coal)	
Petroleum or natural gas production activities	254.1
Petroleum or natural gas activities	71.4
Category total	325.5

Table 3.3.1-5 (cont.). Probable sources of impairment to Kentucky rivers and streams.

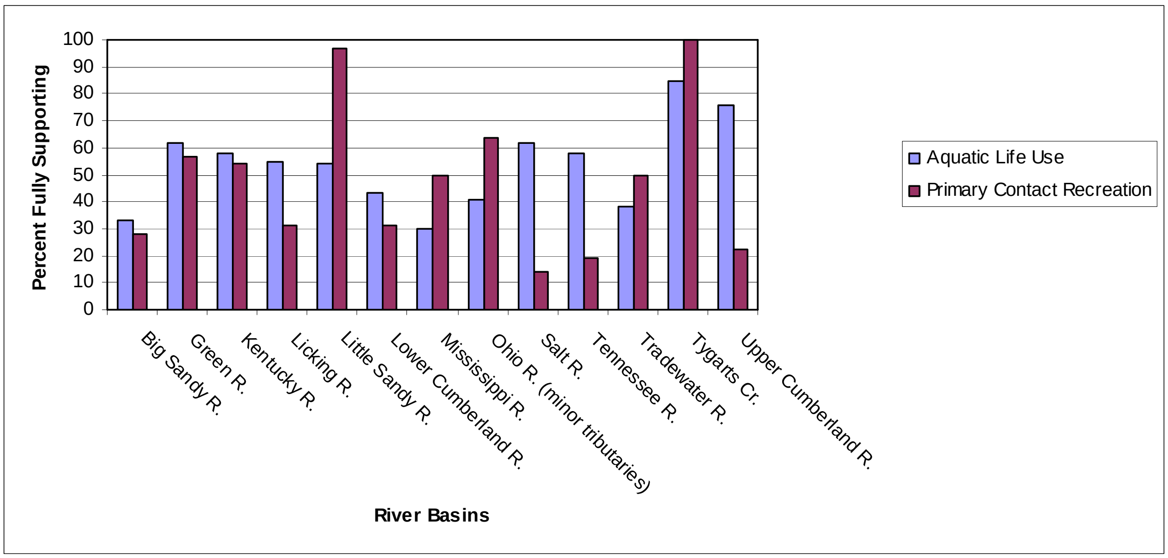
Source Categories	Miles Impacted
Industrial	
Industrial point source discharge	167.8
Industrial or commercial site stormwater discharge (permitted)	15.8
Commercial districts (industrial parks)	4.8
Category total	183.6
Waste Disposal	
Illegal dumps or other inappropriate waste disposal	91.5
Inappropriate waste disposal	59.8
Septage disposal	8.7
Category total	160.0
Hydromodifications: dams or impoundments (stream flow)	
Upstream impoundments (NRCS structures)	48.7
Dam construction (other than upstream flood control projects)	3.2
Category total	51.9
Miscellaneous (does not fit one particular category)	
Introduction of non-native organisms (accidental or intentional)	75.6
Wet weather discharges (nonpoint sources)	43.6
Atmospheric deposition (toxics)	22.7
Runoff from forest, grassland or parkland	21.4
Natural sources	20.0
Drainage, filling or loss of wetlands	15.7
Other spill related impacts	14.8
Upstream source	7.0
Sources outside state jurisdiction or borders	3.6
Nonpoint source pollution from military base facilities (other than port facilities)	2.5
Natural conditions – water quality standards attainability Analyses needed	2.1
Category total	229.0

Table 3.3.1-6. Number of river miles assessed and level of support by use in each major river basin. Those basins in bold type are emphasized in this reporting cycle.				
Basin	Total Assessed	Supporting	Partially Supporting	Not Supporting
Big Sandy				
Aquatic Life	645.3	210.8	274.8	159.7
Fish Consumption	58.7	48.4	15.3	0.0
Swimming	335.7	95.2	21.0	219.5
Drinking Water	48.1	48.1	0.0	0.0
Green River				
Aquatic Life	1616.6	1005.7	352.1	258.8
Fish Consumption	314.4	157.5	85.4	71.5
Swimming	811.8	462.8	49.3	299.7
Drinking Water	274.5	274.5	0.0	0.0
Kentucky River				
Aquatic Life	1844.0	1075.6	555.4	213.0
Fish Consumption	326.4	241.0	74.2	11.2
Swimming	645.8	348.6	145.6	151.6
Drinking Water	169.1	169.1	0.0	0.0
Licking River				
Aquatic Life	763.0	419.0	200.9	143.1
Fish Consumption	55.4	55.4	0.0	0.0
Swimming	475.8	149.1	75.5	251.2
Drinking Water	36.6	36.6	0.0	0.0
Little Sandy				
Aquatic Life	202.4	108.3	85.7	8.4
Fish Consumption	25.6	25.6	0.0	0.0
Swimming	62.1	60.4	0.0	1.6
Drinking Water	14.3	14.3	0.0	0.0
Lower Cumberland				
Aquatic Life	291.7	125.9	92.9	72.9
Fish Consumption	32.2	22.7	9.5	0.0
Swimming	148.4	46.4	34.0	68.0
Drinking Water	35.6	35.6	0.0	0.0

Table 3.3.1-6 (cont.). Number of river miles assessed and level of support by use in each major river basin. Those basins in bold type are emphasized in this reporting cycle.				
Basin	Total Assessed	Supporting	Partially Supporting	Not Supporting
Mississippi River				
Aquatic Life	238.7	66.8	101.8	70.1
Fish Consumption	17.2	17.2	0.0	0.0
Swimming	57.1	28.5	13.3	15.3
Drinking Water	0.0	0.0	0.0	0.0
Ohio River (minor tribs)				
Aquatic Life	188.5	77.3	34.6	76.6
Fish Consumption	11.0	11.0	0.0	0.0
Swimming	78.3	50.1	0.0	28.2
Drinking Water	0.0	0.0	0.0	0.0
Salt River				
Aquatic Life	1029.3	641.25	238.1	149.9
Fish Consumption	73.3	47.0	14.3	12.0
Swimming	471.5	67.8	118.5	285.2
Drinking Water	5.2	5.2	0.0	0.0
Tennessee River				
Aquatic Life	251.4	145.9	92.2	13.3
Fish Consumption	23.5	11.5	6.0	6.0
Swimming	91.9	17.8	31.5	42.6
Drinking Water	5.1	5.1	0.0	0.0
Tradewater River				
Aquatic Life	210.3	79.0	73.3	58.0
Fish Consumption	0.0	0.0	0.0	0.0
Swimming	105.8	53.0	0.0	52.8
Drinking Water	0.0	0.0	0.0	0.0
Tygarts Creek				
Aquatic Life	113.3	96.2	16.0	1.1
Fish Consumption	56.3	10.6	0.0	45.7
Swimming	55.6	55.6	0.0	0.0
Drinking Water	10.6	10.6	0.0	0.0

Table 3.3.1-6 (cont.). Number of river miles assessed and level of support by use in each major river basin. Those basins in bold type are emphasized in this reporting cycle.				
<u>Upper Cumberland</u>				
Aquatic Life	12003.1	912.4	138.1	152.6
Fish Consumption	78.5	72.7	5.8	0.0
Swimming	418.7	91.4	28.7	298.6
Drinking Water	126.0	126.0	0.0	0.0

Figure 3.3.1-2. Aquatic life and primary (swimming) contact recreation use support by major river basins in Kentucky.



3.3.2 Use Assessment Results for 305(b) Reporting Cycle 2004 and 2005

Kentucky River BMU. The Kentucky River Basin is intrastate, with the headwaters rising in southeast Kentucky on the northwest slope of Pine Mountain in Letcher County. The Kentucky River Basin drains 6,965 square miles and contains 16,071 linear miles of streams flowing through all or portions of 41 counties. The main stem of the Kentucky River is approximately 255 miles (410 km); it flows through 14 locks and dams. Major tributaries to the Kentucky River include: 1) Eagle Creek; 2) Dix River; 3) Elkhorn Creek; 4) Red River; 5) North Fork Kentucky River; 6) Middle Fork Kentucky River; and 6) South Fork Kentucky River. Principal cities in the basin are: Hazard, Richmond, Nicholasville, Lexington, Georgetown and Frankfort.

Following are highlights of data and statistical analyses related particularly to the Kentucky River BMU, both targeted and probability based biosurveys to determine aquatic life use and other monitoring results as they relate to each of the four designated uses. Appendix 3.A contains a complete table of monitoring results for each specific water body and segment as related to streams and rivers. For refinement to the degree of use support, nonsupport miles were further subdivided into partial support and nonsupport based on physicochemical, MBI or KIBI scores. This assists KDOW in recognizing the relative degree of potential pollutant and habitat impacts on each system. Appendix 3.B contains reach indexing maps of these assessment results based on NHD 1:24,000 scale map for this BMU.

Impairments, sources and land uses. Impairments (pollutants) and sources of impairments particular to the Kentucky River BMU are listed in Tables 3.3.2-1 and 3.3.2-2, respectively. The Kentucky River drains portions of three physiographic regions (Cumberland Plateau and Mountains, Pennyroyal and Bluegrass). Given the variety of landscapes and geologic differences that occur within this basin, there are contrasting land uses. Of the two BMUs this reporting cycle focuses on, this is the only one with significant coal reserves. Coal extraction is most prevalent in the North and Middle forks of the upper Kentucky River Basin (HUCs 05100201 and 05100202). The land cover in this region is primarily forested with a rural population that exists in the narrow valleys. The major economic activities are mineral extraction and forest-related activity. In landscapes of significant resource extraction, sedimentation and dissolved solids are often the prevailing pollutants as vegetation is removed and bare soil and geologic strata are exposed. Elevated total dissolved solids are a particular concern in these waters that often have low buffering capacity and are naturally infertile. In areas of significant land disturbance and exposure of geologic strata, an abundance of ions from minerals such as magnesium and calcium are liberated into the water column, along with other metals. These two impairments of issue within the BMU, along with related habitat disruption or loss, account for 1198.5 miles of the 1634.3 miles (73.3 percent) impacted by the top five pollutants in the BMU (Table 3.3.2-1). These land uses are reflected in identified sources of the pollutants; the top three are loss of riparian habitat, municipal point source discharges and coal mining. The impairment "other flow regime alterations" is often associated with loss of riparian zone vegetation and subsequent loss of pool habitat in streams due to sediment loading from sloughing banks and overland runoff.

The middle basin (downstream of the confluence of the three forks and upstream of the mouth of the Red River (HUC 05100204) is somewhat of a transition zone between the upper and lower segments of the basin. Resource extraction no longer is a primary activity in the landscape; however, small-scale agriculture production is prevalent and exists primarily of hay production and related grazing of cattle. Due to the physiography of the area, farming exists in the stream and river valleys where broad bottomlands are available to cultivate and produce livestock. The population is primarily rural in this area and is concentrated on the broader river valleys.

The lower Kentucky River BMU is designated by HUC 0500205 and drains the bluegrass region of the commonwealth. This landscape is one of the most populated regions of Kentucky with the second largest urban area, Lexington, near the center of the HUC. During the 1990s and into the early 21st century, this area was one of the fastest growing portions of the state. As with many cities in the U.S., Lexington is experiencing growth issues as urban sprawl supplants what was historically (and is) a major thorough-bred producing region containing many horse farms with pasture and grazing operations dominating most of the area. Through efforts of local governments and citizens, a program to encourage conservation of green spaces by paying a land owner to set aside his farmland from potential development has had some successes. With this type of land use, the fact that sedimentation was the most significant pollutant throughout this diverse BMU brings together the development and resource extraction that are dominant uses found in this basin (Table 3.3.2-1). Municipal point source discharges, the second most common source of pollutants in the BMU, also reflect the extent of urban areas and smaller cities (Table 3.3.2-2).

Table 3.3.2-1. Number of river miles of the top five impairments assessed in the major river basins within the Kentucky River and Salt - Licking River BMUs.

River Basin	Miles
Kentucky River	
Impairments	
Sedimentation/Siltation	579.7
Habitat Assessment (Streams)	385.6
Pathogens	297.2
Total Dissolved Solids	232.1
Other Flow Regime Alterations	164.2
Salt River	
Pathogens	408.0
Sedimentation/Siltation	196.5
Organic Enrichment (Sewage) Biological Indicators	163.9
Nutrient/Eutrophication Biological Indicators	88.9
Benthic-Macroinvertebrate Bioassessments (Streams)	88.2
Licking River	
Pathogens	333.1
Sedimentation/Siltation	252.8
Nutrient/Eutrophication Biological Indicators	179.4
Organic Enrichment (Sewage) Biological Indicators	79.5
Habitat Assessment (Streams)	48.8
Ohio River Minor Tributaries (Licking River BMU)	
Sedimentation/Siltation	62.9
Nutrient/Eutrophication Biological Indicators	49.3
Organic Enrichment (Sewage) Biological Indicators	36.5
Pathogens	28.2
Impairment Unknown	19.0

Table 3.3.2-2. Number of river miles of the top five sources of impairments assessed in the major river basins within the Kentucky River and Salt-Licking River BMUs.

River Basin	Miles
Kentucky River	
Sources	
Loss of Riparian Habitat	754.4
Municipal Point Source Discharges	441.3
Coal Mining	403.5
Managed Pasture Grazing	403.4
Source Unknown	340.8
Salt River	
Municipal Point Source Dischargers	332.6
Urban Runoff/Stormwater Sewers	272.1
Source Unknown	253.2
Municipal (Urbanized High Density Area)	220.2
Loss of Riparian Habitat	213.6
Licking River	
Agriculture	274.8
Source Unknown	180.8
Animal Feeding Operations (NPS)	149.5
Loss of Riparian Habitat	134.1
Crop Production (Crop Land or Dry Land)	132.6
Ohio River Minor Tributaries (Licking River BMU)	
Crop Production (Crop Land or Dry Land)	85.7
Agriculture	46.2
Dredging (e.g. for Navigation)	45.0
Silviculture Activities	38.7
Site Clearance (Land Development or Redevelopment)	34.6

Targeted Monitoring: Aquatic Life Use. The targeted monitoring effort resulted in 1844.0 miles assessed for aquatic life in the Kentucky River BMU (Table 3.3.1-6). This use may be considered the most sensitive to impairments of all uses that apply to streams and lakes because all ecological elements of the aquatic environment must be of a sufficient level of integrity and quality to support aquatic communities dependent on that resource for life (e.g. both in-stream and out-of-stream habitat [riparian corridor and buffer zone] and water quality). A result of targeted monitoring was the addition of 19 candidate reference reach or exceptional streams or segments; these streams total 60.3 miles (Table 3.1.4-2). This is about 3.3 percent of the targeted total stream miles assessed. It should be noted as each cycle phase is repeated a fewer number of stream miles will likely be added to the reference reach list since there has been a concerted effort to locate all suspected least impacted streams previously. However, identifying new stream segments as exceptional (401 KAR 5:030) will be a part of KDOW's overall monitoring strategy.

Approximately 58 percent of targeted miles were in full support of aquatic life use, whereas 42 percent of all targeted miles assessed did not fully support (Table 3.3.1-6). While the majority of miles assessed at targeted monitoring locations for aquatic life were assessed based on biological monitoring, some of those miles were assessed using water physicochemical data at long-term and rotating watershed locations.

Targeted Monitoring: Fish Tissue. Fish tissue samples were analyzed for mercury and PCB burden in the Kentucky River BMU. Of the 326.4 miles assessed for fish consumption, 241.0 (about 74 percent) were in full support (Table 3.3.1-6). Approximately 85 miles (26 percent) were not fully supporting this use.

Targeted Monitoring: Primary (Swimming) Contact Recreation. Water column samples were analyzed for the presence and quantity of fecal coliform colonies to assess this use support. There were 645.8 river miles assessed in the Kentucky River BMU (Table 3.3.1-6). Of those river miles, 348.6 (54 percent) (Figure 3.3.1-2) were fully supporting and 297.2 miles (46 percent) were partially or not supporting this use (Table 3.3.1-6). The North Fork Kentucky River (Chavies to headwaters) has had a long-standing swimming advisory based on pathogens that remains in effect as of this BMU cycle phase. There were two primary issues related to this high concentration of fecal coliform colonies: municipal point source discharges, with a number of bypasses at wastewater treatment facilities, and straight-pipes discharging untreated household wastewater. Both sources can be tied to topography of the region, which is mountainous with narrow valleys associated with stream and river courses. These valleys provide much of the suitable land where housing can exist with reasonable access. However, available land to construct septic systems with needed lateral lines typically does not exist. The soils in these bottomlands often are poorly drained, further restricting proper on-site treatment in rural areas. A related scenario exists for the wastewater treatment facilities, which often are built in the flood zone of rivers, as these areas provide the limited sites to seat a facility.

Targeted Monitoring: Drinking Water Supply. All miles (169.1) assessed in the Kentucky River BMU were fully supporting this use (Table 3.3.1-6).

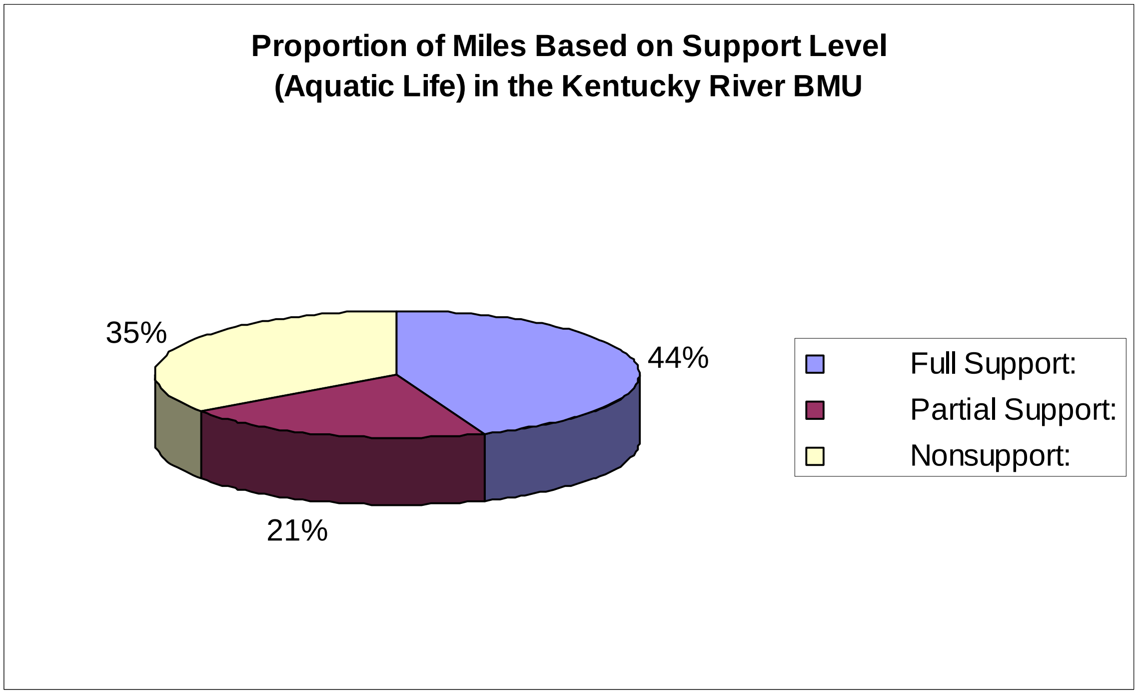
Probability Biosurvey of BMU. The Kentucky River BMU was sampled according to EMAP and Kentucky SOP (2006) protocol. Because of significant refinement and calibration to KDOW's MBI, comparisons to the 1998 results were problematic and not comparable; therefore, drawing trend information comparisons between the two monitoring years was not possible. As Table 3.3.2-3 shows, out of 17,595.8 miles of target stream resources, 16,995.5 miles were represented in the probability analysis. Once the probability data were extrapolated, 7497.0 miles or 44 percent of wadeable streams in this BMU were fully supporting aquatic life use, while 3560.4 miles or 21 percent of wadeable streams were partially supporting, and 35 percent were not supporting the aquatic life use (Table 3.3.2-3 and Figure 3.3.2-1).

Table 3.3.2-3. Aquatic use attainment results based on the 2003 probability biosurvey of the Kentucky River BMU.

Project ID	Kentucky River BMU Probability Survey
Target Population	Streams Strahler Order 1-5
Sample Frame	EPA River Reach File 3 (1:100,000 Scale)
Type of Water body	Wadeable Streams
Size of Target Population	17,595.8 mi
Size of Non-Target Population	3009.0 mi
Size of Target Sampled Population	16,995.5 mi
Designated Use	Aquatic Life
Attaining Full Use	7497.0 mi
Not Attaining Full Use (partial support)	3560.4 mi
Not Attaining Full Use (nonsupport)	5938.1
Indicator	Biology (Macroinvertebrates)
Assessment Date	2004
Precision	93% at 95% Confidence Level

Probability and Targeted Monitoring Compared (Aquatic Life Use). Probability and targeted monitoring results differed to a degree in the Kentucky River BMU (Table 3.3.2-4). In this BMU, the reference reach and other programs identified 53.2 miles or 2.9 percent of targeted streams as candidates for exceptional water designation (Table 3.1.4-2) during monitoring in 2003, and a number of miles were assessed as follow-up surveys on designated reference reach stream segments (Table 3.1.4-1). In the BMU-wide

Figure 3.3.2-1. Proportions of aquatic life use support in the Kentucky River BMU based on probability biosurveys. Pie chart represents the entire defined stream population (Strahler order 1 – 5) in the basin.



assessment data (stream miles) (including all monitoring efforts from 2003 and prior) targeted monitoring results include 243.1 miles (13 percent) of reference reach assessments, 395.8 miles (21 percent) of assessment results based on physicochemical data only, 346.7 stream miles (19 percent) using probability data for site-specific assessments. The balance of remaining mileage (858.4 miles [53 percent]) for other targeted monitoring efforts such as monitoring large order streams at most of the Primary Ambient Water Quality stations (refer to Table 3.1.1-1), fish only sites conducted by KDFWR, and streams monitored for possible exceptional water designation, but did not meet the higher criteria. Thus, 34 percent of all stream miles assessed for aquatic life use were based on reference reach and physicochemical programs. Of that 34 percent from targeted only reference reach and physicochemical programs, zero miles were nonsupporting based on results from these two monitoring programs. The streams with only physicochemical data are generally large (> 5th order) rivers that provide a considerable amount of dilution, and the chance of collecting water at the time any one particular pollutant passes with a concentration high enough to exceed water quality criteria are small. Many of the remaining targeted stream miles (858.4) (47 percent) are Strahler order 4 or greater, whereas probability monitoring design selects an equitable number of Strahler order 1 and 2 streams, in addition to Strahler order 3 - 5. These smaller watersheds show stress in biological communities to relatively smaller-scale perturbations than the large watersheds which can often assimilate more disturbances relative to watershed size. Also, the approach to locating sample locations differs significantly between the two biological programs. The targeted stations are located in the best available stream reach, whereas the probabilistic approach is designed to randomly detect the prevailing habitat and associated biological conditions in a defined stream population (like Strahler order watersheds) at randomly selected locations throughout the study area (BMU).

Table 3.3.2-4. Comparison of probability and targeted monitoring results for aquatic life use in the Kentucky River BMU (Note: percentages rounded to nearest integer).

	Full Support		Partial Support		Nonsupport	
	Probability	Target	Probability	Target	Probability	Target
Miles	7497.0	18844.0	3560.4	555.4	5938.1	213.0
Percent	44	58	21	30	35	11

Salt River Basin. The Salt River Basin is intrastate and drains about 4,150 square miles of parts or all of 18 counties in north-central Kentucky. The headwaters of the Salt River rise in Boyle County in the Knobs-Norman Upland (Ecoregion 71c). From there it flows northward into southern Anderson County where it bends westward to its eventual confluence with the Ohio River near West Point, Bullitt County. Along this course it picks up four principal tributaries, Rolling Fork, Chaplin River, Beech Fork and Floyds Fork. The streams in the Silver - Little Kentucky River HUC (05140101) of the Salt River Basin discharge directly into the Ohio River. According to 1:24,000 scale NHD map, there are 9,620.6 miles of streams in this basin. The watershed is bounded on the north and west by the Ohio River, on the east by the drainage divide with the Kentucky River Basin, and on the south by the drainage divide with the Green River Basin. The general topography ranges from nearly flat along alluvial plains to gently rolling pastures to hilly, steeply sloping hillsides in upland areas. The elevation of land surface ranges from slightly less than 400 feet to more than 1,200 feet above mean sea level. Data from the U.S. Census

Bureau indicate that six counties in the basin had the largest percent of population increase during 1990-1999. These counties and their rankings compared to the 120 total counties in Kentucky are Spencer County (1 out of 120), Oldham County (4 out of 120), Trimble County (7 out of 120), Anderson County (8 out of 120), Bullitt County (9 out of 120) and Nelson County (10 out of 120). Principal cities in the watershed include Louisville-Jefferson County, Radcliff, LaGrange, Shelbyville and many smaller communities.

Following are highlights of data and statistical analyses related particularly to the Salt River Basin, both targeted and probability-based biosurveys to determine aquatic life use and other monitoring results as they relate to each of the four designated uses. Appendix A contains a table of complete monitoring results for each specific water body and segment as related to streams and rivers. For refinement to the degree of use support, nonsupport miles were further subdivided into partial support and nonsupport based on physicochemical, MBI or KIBI scores. This assists KDOW in recognizing the relative degree of potential pollutant and habitat impacts on each system. Appendix 3.C contains reach indexing maps of these assessment results based on NHD 1:24,000 scale for this basin.

Impairments, sources and land uses. Impairments (causes) and sources of impairments particular to the Salt River Basin are listed in Tables 3.3.2-1 and 3.3.2-2, respectively. The Salt River Basin courses through one of the most densely populated areas of Kentucky, and this footprint of urban or municipal land uses is magnified given the relative drainage area in relation to basin area. Aside from urban areas, the landscape is dotted with small towns and mixed agriculture. The geologic strata are composed of sedimentary rock, primarily limestone. Soils are rich in phosphate, but less so than those in the Inner Bluegrass Ecoregion adjacent to this area. Because of this natural source of phosphorus, any increase of nitrogen above what occur naturally may trigger algal blooms in streams and manmade lakes under certain environmental and physical conditions. Organic enrichment was segregated into two sources, either sewage-related sources or all other sources (e.g. agriculture, lawn amendments to residences or urban parks, golf course turf management, etc.). If the issue of nutrients and organic enrichment is looked upon as a single concern it is the second most frequent occurrence of impairment by stream mileage in the basin (Table 3.3.2-1). Significant stream miles in the middle and lower portion of the basin had luxuriant growths of *Chladophora*, particularly in areas of intensive agricultural land uses where the riparian zone vegetation had been removed and there was increased nutrient runoff from nonpoint sources; this also was significant in suburban areas associated with intensive turf management. Data in Table 3.3.2-1 show that while pathogens were the leading impairment, if the two source-types of organic enrichment impairments were combined, then nutrient impairment would be the second most commonly identified impairment (pollutant) in the BMU. Sedimentation not only smothers habitat and aquatic life, but nutrients, bacteria and other compounds are often bound to soil particles and transported into rivers and streams.

The leading sources of impairments were associated with urban and suburban areas, which reflect the significant population that resides in this basin (824.9 stream miles out of 837.2 miles not supporting assessed uses [Tables 3.3.1-6 and 3.3.2-2]).

Targeted Monitoring: Aquatic Life Use. This basin has a high level of fully supporting stream miles for aquatic life use based on targeted monitoring (approximately 62 percent) (Table 3.3.1-6). This is an important distinction to note since this use represents the health and overall water and habitat qualities of aquatic communities in this basin. This use may be considered the most sensitive to impairments of all uses that apply to streams and lakes because nearly all ecological elements of the aquatic environment must be of a sufficient level of integrity and quality to support aquatic communities dependent on that resource for life (e.g. both in-stream and out-of-stream habitat [riparian corridor and buffer zone] and water quality). Total miles of targeted monitoring for this use was 1029.3 (Table 3.3.1-6). The majority of stream miles were monitored using biological indicators (primarily macroinvertebrates and/or fishes) on which to base assessment decisions; however, large, nonwadeable rivers and streams were assessed using physicochemical data collected over a minimum 12-month time period, and many of the stations' results were a compilation of three years of monitored data.

There were 7.3 miles of candidate exceptional stream segments identified from this second cycle of intensive monitoring in this basin (Table 3.1.4-2). These miles of candidate exceptional segments represent only 0.7 percent of the total number of miles assessed for this use.

Targeted Monitoring: Fish Tissue. Fish tissue samples were analyzed for mercury and PCB burden in the Salt River Basin. Fish consumption was assessed in 73.3 miles; of those miles assessed, 47.0 (about 64 percent) were full support (Table 3.3.1-6). A total of 26.3 miles, or 36 percent, were not fully supporting this use, and one-half of those miles resulted in mercury concentrations above 1.0 µg/g, which triggers an advisory for no consumption.

Targeted Monitoring: Primary (Swimming) Contact Recreation. Water column samples were analyzed for the presence and quantity of fecal coliform colonies to assess this use support. There were 471.5 river miles assessed in the Salt River Basin (Table 3.3.1-6). Of those river miles, 67.8 (14 percent) (Figure 3.3.1-2) were fully supporting and 403.7 miles (86 percent) were partially or not supporting this use. The majority of those stream miles not supporting this designated use were located in the Louisville-Jefferson County metropolitan area. There were three primary sources related to this high concentration of fecal coliform colonies: municipal point source discharges with bypasses at wastewater treatment facilities, urban runoff/stormwater sewers and municipal urbanized high density area. These issues are those that confront many municipalities and major urban areas in the U.S. because of population growth, aging and inadequate infrastructure and the lack of funding for upgrading and expanding infrastructure. With the planned expansion of regional wastewater treatment facilities and subsequent elimination of package wastewater facilities, it is anticipated the level of pathogens in these urban waters will be significantly reduced.

Targeted Monitoring: Drinking Water Supply. All miles assessed in the Salt River Basin fully supported this use (Table 3.3.1-6).

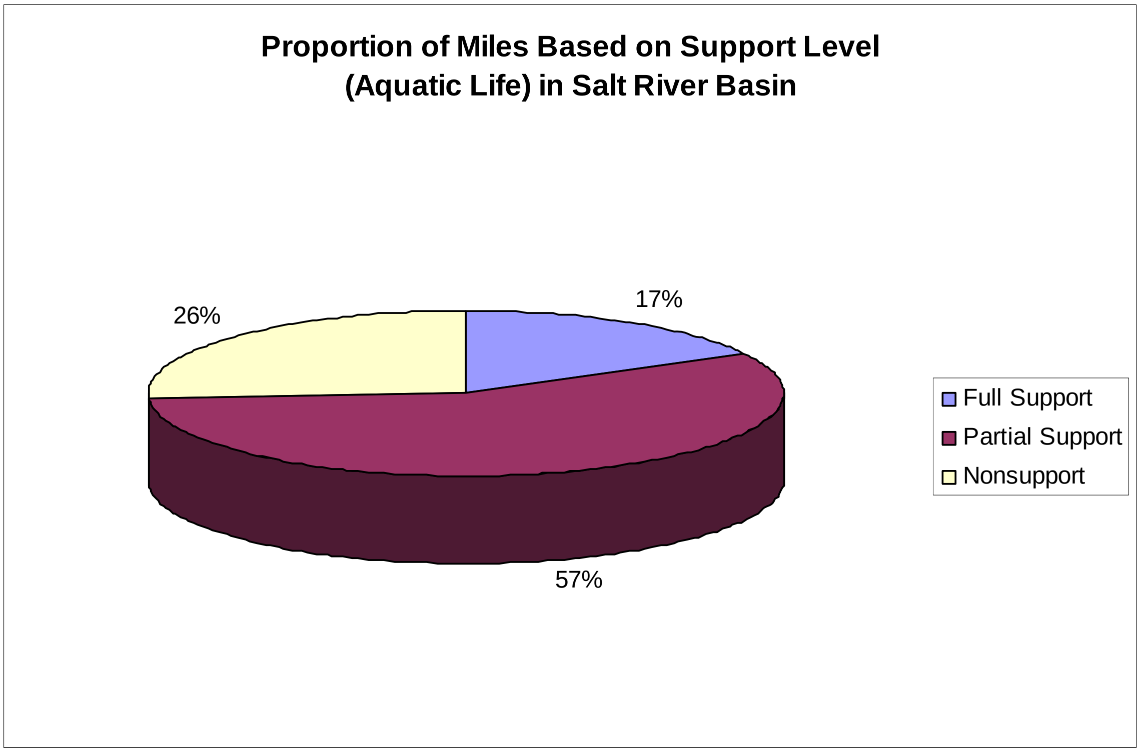
Probability Biosurvey of Salt River Basin. The Salt River Basin was sampled according to EMAP and Kentucky SOP (2006) protocol. Because of significant refinement and calibration to KDOW's MBI, comparisons to the 1999 results were problematic and not comparable; therefore, drawing trend information comparisons between the two monitoring years was not possible. Also, to further complicate data analyses comparisons, 1999 was a year of severe drought in Kentucky and much of the southeastern U.S. Thus, many headwater streams that might have been expected to be part of the survey were excluded. As Table 3.3.2-5 shows, out of 3464.98 miles of target stream resources, 3371.13 miles were represented in the probability analysis. Once the probability data were extrapolated, 584.4 miles or 17 percent of wadeable streams in this BMU were fully supporting aquatic life use, while 2880.5 miles or 83 percent of wadeable streams were not fully supporting that use (Table 3.3.2-5 and Figure 3.3.2-2).

Table 3.3.2-5. Aquatic life use attainment results based on the 2004 probability biosurvey of the Salt River Basin.

Project ID	Salt River Basin Probability Survey
Target Population	Streams Strahler Order 1-5
Sample Frame	EPA River Reach File 3 (1:100,000 Scale)
Type of Water body	Wadeable Streams
Size of Target Population	3464.98 mi
Size of Non-Target Population	882.07 mi
Size of Target Sampled Population	3371.13 mi
Designated Use	Aquatic Life
Attaining Full Use	584.43 mi
Not Attaining Full Use	2880.53 mi
Indicator	Biology (Macroinvertebrates)
Assessment Date	2005
Precision	90% at 95% Confidence Level

Probability and Targeted Monitoring Compared (Aquatic Life Use). Probability and targeted monitoring results differed considerably in the Salt River Basin (Table 3.3.2-6). In this basin, the reference reach and other programs identified 7.3 miles or 0.7 percent of targeted streams as candidates for exceptional water designation (Table 3.1.4-2), and a number of miles were assessed as follow-up surveys on designated reference reach stream segments (Table 3.1.4-1). In the BMU-wide assessment data (including all monitoring efforts from 2004 and prior), targeted monitoring results include 45.8 (4 percent) miles of reference reach assessments, 185.8 miles (18 percent) of assessments based solely on physicochemical data, 199.0 (19 percent) miles using probability data for site-specific assessments, and 599.2 miles (approximately 58 percent) for other targeted monitoring efforts such as monitoring large order streams at most of the Primary Ambient Water Quality Stations, fish collection only sites and streams monitored for possible exceptional water designation. Thus, 22 percent of all stream miles assessed for aquatic

Figure 3.3.2-2. Proportions of aquatic life use support in the Salt River Basin based on probability biosurveys. Pie chart represents the entire defined stream population (Strahler order 1 – 5) in the basin.



life use were based on reference reach and physicochemical programs alone. Of that 22 percent, zero miles were nonsupporting based on results from these two monitoring programs. Many of the remaining (other than reference reach) targeted streams (599.2 miles, approximately 58 percent) are in Strahler order 4 or greater; the physicochemical stations are located on streams >5th order. Those physicochemical river stations provide a considerable amount of dilution, and the chance of collecting water with a concentration high enough to exceed water quality criteria is small. Many of the remaining targeted stream miles (other than reference reach) (499.8) are Strahler order 4 or greater, whereas the probability monitoring design selects an equitable number of Strahler order 1 and 2 streams, in addition to Strahler order 3 – 5. These smaller watersheds show stress in biological communities to relatively smaller-scale perturbations than the large watersheds which can often assimilate more disturbances relative to watershed size. Also, the approach to locating sample stations differs significantly between the two biological programs. The targeted stations are located in the best available stream reach, whereas the probabilistic approach is designed to randomly detect the prevailing habitat and associated biological conditions in a defined stream population (like Strahler order watersheds) at randomly selected locations throughout the study area (BMU).

Table 3.3.2-6. Comparison of probabilistic and targeted monitoring results for aquatic life use in the Salt River Basin (Note: percentages rounded to nearest integer).

	Full Support		Partial Support		Nonsupport	
	Probability	Target	Probability	Target	Probability	Target
Miles	584.43	641.25	1989.56	238.10	890.97	149.90
Percent	17	65	57	22	26	14

Licking River Basin. The Licking River drains a diverse watershed, with forested hills and low mountains in the upper reaches, rolling farmland along the middle region and an urban center with much industrial development near the confluence with the Ohio River in northern Kentucky. The Licking River was named for the mineral springs and salt licks that attracted buffalo and other animals to the basin; it rises in the highlands of the Central Appalachians in Magoffin County. The elevation ranges from about 1500 feet in the headwaters to about 460 feet above mean sea level at the mouth. The river flows northwest crossing three Level III Ecoregions and has a length of about 300 miles before discharging into the Ohio River between Newport and Covington. This basin drains all or portions of 20 counties and is intrastate. It is bordered on the north by the Ohio River, south by the Kentucky River basin and to the east by the Big Sandy – Little Sandy – Tygarts basins. The two principal tributaries are the North Fork, which joins the main stem of the river near Milford, and the South Fork, which joins at Falmouth. According to NHD (1:24,000 scale), there are 9570.4 miles in the basin (HUCs 05100101 and 05100102) and another 2086.8 miles in HUC 05090201 which is drained by minor tributaries to the Ohio River, the largest being Kinniconick Creek. The Licking River drains an area of roughly 3,600 square miles, or about 10 percent of the entire state. A dam near the town of Farmers on the Rowan - Bath county line (about 173 miles upstream from the Ohio River) forms Cave Run Lake, an 8,300-acre reservoir that impounds approximately 30 miles of the main stem and the lower reaches of several tributaries. Smaller, low-water dams occur on Slate Creek, Stoner Creek, South Fork Licking River and other streams.

Following are highlights of data and statistical analyses related particularly to the Licking River Basin, both targeted and probability-based biosurveys to determine aquatic life use and other monitoring results as they relate to each of the four designated uses. Appendix 3.A contains a table of complete monitoring results for each specific water body and segment as related to streams and rivers. For refinement to the degree of use support, nonsupport miles were further subdivided into partial support and nonsupport based on physicochemical, MBI or KIBI scores. This assists KDOW in recognizing the relative degree of potential pollutant and habitat impacts on each system. Appendix 3.D contains reach indexing maps of these assessment results based on NHD 1:24,000 scale for this basin.

Impairments, sources and land uses. Impairments (causes) and sources of impairments particular to the Licking River basin are listed in Tables 3.3.2-1 and 3.3.2-2, respectively. As with the Salt River Basin, pathogens were the leading impairment in this basin, and sediment and siltation the second most commonly identified pollutant. While the Salt River Basin may mirror this basin in terms of impairments, the sources were tied to agriculture and related activities that occurred primarily in the lower two-thirds of the basin. The upper one-third of the basin was primarily forested and rugged terrain. This physiography dictates that communities be located in floodplains and narrow valleys associated with streams in the area. Two impairments (pathogens and sedimentation) were affected 585.9 stream miles (65.6 percent) of the 893.6 miles impacted by the top five impairments in the basin (Table 3.3.2-1). Of the top five most commonly identified sources of impairment, three were directly tied to agriculture, accounting for 556.9 stream miles (63.9 percent) (Table 3.3.2-1). One of the most detrimental effects of stream habitat integrity affecting the aquatic life use support level is the source "Loss of Riparian Habitat" identified as the fourth most common source of impairment in the basin (Table 3.3.2-2). This is a source that is often a direct result of other land-use-related sources of impairments such as agriculture, resource extraction and residential land uses, and is a major contributing factor to sedimentation and siltation.

The lower one-third of this basin becomes progressively more urban. Here pathogens are contributed primarily through municipal point source discharges and urban runoff or stormwater sewers. Kenton and Campbell counties in northern Kentucky are densely populated with impervious surfaces being a significant percentage of land cover in the lower most 20 miles of the river. Upgrades to stormwater sewers and POTWs in the planning or implementation phase should improve runoff and overflows associated with urban infrastructure.

Targeted Monitoring: Aquatic Life Use. This basin had a support level for aquatic life use of about 55 percent of miles assessed based on targeted monitoring (Table 3.3.1-6). This support level was comparable to that for the Kentucky River BMU. This use may be considered the most critical of all uses that apply to streams and lakes because all ecological elements of the aquatic environment must be of a sufficient level of integrity and quality to support aquatic communities dependent on that resource for life (e.g. both in-stream and out-of-stream habitat [riparian corridor and buffer zone] and water quality). Total miles of targeted monitoring for this use were 763.0 (Table 3.3.1-6). The majority of stream miles were monitored using biological indicators (primarily macroinvertebrates or fishes) on which to base assessment decisions; however, large, nonwadeable rivers and streams were assessed using physicochemical data collected over a minimum 12-month time period, and many of the stations' results were a compilation of three years of monitored data.

There were 43.1 miles of candidate exceptional streams identified from this second cycle of intensive monitoring of this basin (Table 3.1.3-2). These miles of candidate exceptional segments represent only 5.7 percent of the total number of miles assessed for aquatic life use. The commonwealth is in the second rotational BMU cycle of intensive monitoring which has led to many miles of exceptional and reference reach stream segments identified. Given that this has been a priority in development and refinement of multimetric indices for many years now, it is likely that the pace at which additional streams will qualify as exceptional and reference reach stream segments will slow as the majority of these waters have been identified. However, identifying new stream segments as exceptional (401 KAR 5:030) will be a part of KDOW's overall monitoring strategy.

Targeted Monitoring: Fish Tissue. Fish tissue samples were analyzed for mercury and PCB burden in the Licking River Basin. Of the 55.4 miles surveyed, all were found to be supporting.

Targeted Monitoring: Primary (Swimming) Contact Recreation. Water column samples were analyzed for the presence and quantity of fecal coliform colonies to assess this use support. There were 475.8 river miles assessed in the Licking River basin (Table 3.3.1-6). Of those river miles, 149.1 (31 percent) (Table 3.3.1-6 and Figure 3.3.1-2) were fully supporting and 326.7 miles (69 percent) were partially or not supporting this use (Table 3.3.1-6). The lower Licking River basin has a long-standing swimming advisory in two tributaries, Banklick and Threemile creeks. Pathogens were the number one impairment affecting the stream miles in this basin (Table 3.3.2-1). There was no distinct pattern in the basin where the nonsupporting streams occur; however, the majority of affected stream miles were in the middle portion of the basin. This area is rural and primarily agricultural. Many grazing operations for both horses and cattle exist in this area. Agriculture was the major source of impairments in this basin (Table 3.3.2-2). One other area where significant stream miles impaired by pathogens exist was in the lower basin, near an area of urban development.

Targeted Monitoring: Drinking Water Supply. All miles assessed in the Licking River Basin were fully supporting this use (Table 3.3.1-6).

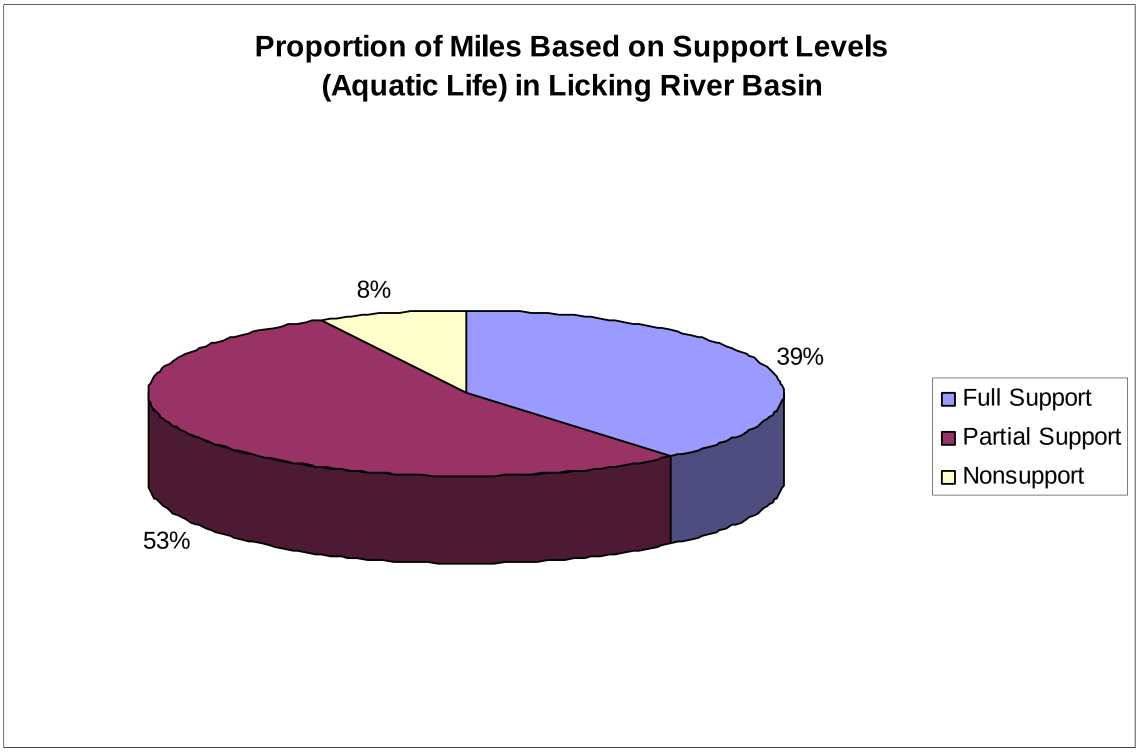
Probability Biosurvey of Salt River Basin. The Licking River basin was sampled according to EMAP and KDOW SOP (2006) protocol. Because of significant refinement and calibration to KDOW's MBI, comparisons to the 1999 results were problematic and not comparable; therefore, trend information comparisons between the two monitoring years were not made. Also, to further complicate data analyses comparisons, 1999 was a year of severe drought in Kentucky and much of the southeastern U.S. Thus, many headwater streams that might have been expected to be part of the survey were excluded because of those drought conditions. As Table 3.3.2-7 shows, out of 5811.7 miles of target stream resources, 5616.4 miles were represented in the probability analysis. Once the probability data were extrapolated, 2263.9 miles or 39 percent of wadeable streams in this BMU were fully supporting aquatic life use, while 3547.8 miles or 61 percent of wadeable streams were not fully supporting that use (Table 3.3.2-5 and Figure 3.3.2-3). This probability survey did find a considerably greater aquatic life use support level for this basin as compared to the Salt River Basin (39 percent compared to 17 percent). It is likely that less impervious surface and differences in land use were primarily responsible for these findings.

Table 3.3.2-7. Aquatic use attainment results based on the 2004 probability biosurvey of the Salt River Basin.

Project ID	Licking River Basin Probability Survey
Target Population	Streams Strahler Order 1-5
Sample Frame	EPA River Reach File 3 (1:100,000 Scale)
Type of Water body	Wadeable Streams
Size of Target Population	5811.74 mi
Size of Non-Target Population	390.73 mi
Size of Target Sampled Population	5616.37 mi
Designated Use	Aquatic Life
Attaining Full Use	2263.94 mi
Not Attaining Full Use	3547.80 mi
Indicator	Biology (Macroinvertebrates)
Assessment Date	2005
Precision	90% at 95% Confidence Level

Probability and Targeted Monitoring Compared (Aquatic Life Use). Probability and targeted monitoring results differed in the Licking River Basin (Table 3.3.2-8). In this basin, the reference reach and other programs identified 43.1 miles or 5.7 percent of targeted streams as candidates for exceptional water designation (Table 3.1.4-2), and a number of miles were assessed as follow-up surveys on designated reference reach stream segments (Table 3.1.4-1). In the BMU-wide assessment data targeted monitoring results include 59.1 miles (8 percent) of reference reach assessments, 66.8 miles (9 percent) of assessments based on physicochemical data only, 137.3 miles (18 percent) using probability data for site-specific assessments. The remaining 499.8 miles (65 percent) were from other targeted monitoring efforts such as monitoring large order streams at most of the Primary Ambient Water Quality stations (refer to Table 3.1.1-1), fish only sites conducted by KDFWR, and streams monitored for possible exceptional water designation. Many of the targeted streams are Strahler order 4 or greater whereas probability monitoring design selects an equitable number of Strahler order 1 – 5 streams. These smaller watersheds manifest stress in biological communities to relatively smaller-scale perturbations than large watersheds which can often assimilate more disturbances relative to watershed size.

Figure 3.3.2-3. Proportions of aquatic life use support in Licking River Basin based on probability biosurveys. Pie chart represents the entire defined stream population (Strahler order 1 – 5) in the basin.



Also, the approach to locating sample stations differs significantly between the two biological programs. The targeted stations are located in the best available stream reach, whereas the probabilistic approach is designed to randomly detect the prevailing habitat and associated biological conditions in a defined stream population (like Strahler order watersheds) at randomly selected locations throughout the study area.

Table 3.3.2-8. Comparison of probabilistic and targeted monitoring results for aquatic life use in the Licking River Basin (Note: percentages rounded to nearest integer).

	Full Support		Partial Support		Nonsupport	
	Probability	Target	Probability	Target	Probability	Target
Miles	2263.94	419.00	3104.06	200.90	443.74	143.10
Percent	39	55	53	26	8	19

3.3.3 Ohio River

ORSANCO assessed uses in the 664 miles of the Ohio River main stem that forms Kentucky's northern boundary and a summary of those findings are presented in the ORSANCO 2006 305(b) report. No reaches of the Ohio River fully support all uses. Drinking water and aquatic life use are fully supported in all river miles. Eighteen segments along this reach were not fully supporting primary contact recreation use due to pathogens. Of the 664 miles that form Kentucky's northern border, those 18 segments represent 350 miles (53 percent) that did not fully support the use. This limited support was often a result of combined sewer overflows (CSOs) during and immediately following rainfall events in and downstream of urban areas. All miles of the Ohio River partially supported the fish consumption use because of limited fish consumption advisories for PCBs and dioxin.

3.3.4 Water Quality Trend Analysis

Methods. Six water quality variables were evaluated for trend patterns of data at 23-primary long-term ambient monitoring stations. Those water quality variables thought to be of most significance were: 1) total suspended solids; 2) specific conductance 3) nitrite-nitrate; 4) total phosphorus; 5) sulfates; and 6) chloride. To meet the criterion for long-term monitored data, the stations selected from KDOW's 71 primary ambient water quality network were those that had a minimum of 25 years of monitored data (typically either monthly or bimonthly). Data were downloaded from STORET – the USEPA water quality storage and retrieval database. All subsequent work was performed using Microsoft Excel. Summary statistics were determined for the raw dataset. Summary statistics for the dataset include: median, 10th, 25th and 90th percentiles.

In the absence of water quality statistical software, control charts were used to determine trends in the dataset. John K. Taylor, in his book *Quality Assurance of Chemical Measurements* (1987), states that control charts provide a graphical means of understanding a variety of process issues. Control charts have been used to monitor and document critical aspects of samples and sampling operations and to detect trends in laboratory process systems.

The recommended procedure for development of control charts uses the mean of a number of measured values of the variable as the central line and the standard deviation to establish the control and warning limits. The central line (the mean of all measured values) is bracketed by a warning line (+ or – twice the standard deviation [2σ]), or a control line (+ or – three times the standard deviation [3σ]).

Trend analysis. To identify trends in a dataset, the dataset was first assessed for outliers. Outliers have been defined as, "an observation that does not conform to the pattern established by other observations (Gilbert, 1987). To assess for outliers, an approach called the "Box plot rules" presented by Eric Aroner in his WQHYDRO – Water Quality/Hydrology Graphics/ Analysis User's Manual (1993) – was employed; the procedure is:

{LQ (lower quartile) 25th %tile– (3.0 IQR [interquartile range])} ≤ X ≤ (UQ [upper quartile] 75^{th} %tile + (3.0 IQR [interquartile range])}.

Aroner stated that using 3.0 results in an extremely low chance of non-inclusion for what were labeled *far-outside fences* (i.e. data outliers). Those data outside the above calculated range were excluded from trend analysis. This normally resulted in exclusion of less than five percent of the raw data.

- Total mean and standard deviation statistics were next computed for the dataset. This mean served as the central line for the control charts. Standard deviations (2σ and 3σ) based on the dataset standard deviation were computed to serve as the control and warning limits.
- Control charts were then developed.
- As almost all yearly mean concentrations were within one standard deviation around the central line, charts that display the 0.5 σ warning line were developed.
- The resultant control charts were then visually examined to see if any trends were evident. Those charts which appeared to contain trends were handled in the following way.
    - The mean of five-year datasets of pollutant concentrations was computed. These means were then applied to the charts.
    - A trend was determined to exist if three consecutive five-year interval means were either increasing or decreasing. If less than three consecutive years were increasing or decreasing, no trend was determined to exist.

Results. Twenty trends were determined; of those 20 trends, 10 were decreasing and 10 were increasing (Table 3.3.4-1). Of those variables showing trends, specific conductance was the most common and was increasing in five-sixths of observations. Of those five increasing trends for specific conductance, with one exception, all stations were located in areas of coal mining activity (Table 3.3.4-2). The Kentucky River near Frankfort was the only station outside of coal mining regions indicating an increasing trend for specific conductance.

Table 3.3.4-1. Water quality variable trend observations and frequencies (number of stations).

Water Quality Variable	Increasing Trend	Decreasing Trend
Specific Conductance	5	1
Sulfate	4	1
Total Phosphorus	0	4
Nitrite + Nitrate	1	1
Chloride	0	1
Total Suspended Solids	0	1

Of the ongoing land uses identified to be primary stressors of streams in this region (mining, silviculture, residential and commercial development, agriculture, and road, railroad and bridge construction), mining and residential development are the most pervasive and occur in smaller watersheds where mountain streams are directly exposed to chemical and physical disturbances (Pond, 2004). Various studies have shown that high concentrations of dissolved ions such as chlorides and sulfates detrimentally affect water quality and the aquatic communities of streams (Branson and Batch, 1972; Howard et al.

Table 3.3.4-2. Primary long-term water quality stations with detectable water quality variable trends.

Stream Name	Basin	Variable	Trend Increasing	Trend Decreasing
Cumberland River near Burkesville	Upper Cumberland	Total Suspended Solids (TSS)		X
Kentucky River at Frankfort	Kentucky	Sulfate	X	
N. Fk. Kentucky River at Jackson	Kentucky	Specific Conductance	X	
Levisa Fork near Pikeville	Big Sandy	Specific Conductance	X	
		Sulfate	X	
Salt River at Shepherdsville	Salt	Total Phosphorus		X
Pond River near Sacramento	Green	Total Conductance (1979-1995)	X	
		Total Conductance (1995-2004)		X
		Chloride		X
		Nitrite-Nitrate		X
		Sulfate		X
Tug Fork near Kermit, WV	Big Sandy	Specific Conductance	X	
		Chloride		X
		Total Phosphorus		X

2001; and Pond, 2004). Sedimentation and habitat modifications are also important watershed impacts negatively affecting stream health (Pond and McMurray, 2002).

3.3.5 Assessment Results of Lakes and Reservoirs: Focus on Kentucky and Salt - Licking Rivers BMUs

Introduction. Since the initiation of the rotating basin approach in 1998, the Commonwealth's significant publicly-owned reservoirs are monitored over a five-year cycle instead of the previous seven- to eight-year cycle. During this two-year reporting period, 18 impoundments and reservoirs in the Kentucky River Basin, 12 in the Salt River Basin and eight in the Licking River Basin were monitored (figures located in Appendix C).

Designated uses in lakes consist of Warm Water Aquatic Habitat (WAH) (sometimes in conjunction with Cold Water Aquatic Habitat (CAH) in lakes with a two-story fishery) and Primary and Secondary Contact Recreation (PCR and SCR). Many reservoirs also have a domestic water supply (DWS) use. Indicators monitored or sampled for analysis to determine lake or reservoir health may be found in Table 3.2.1-1.

3.3.5.1 Assessment of Trophic State and Use Support.

Trophic status was assessed in lakes by using the Carlson Trophic State Index (TSI) for chlorophyll *a*. This method is convenient because it allows lakes to be ranked numerically according to increasing eutrophy, and it also provides for a distinction between oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic lakes. The growing season (April – October) average TSI value was used to rank each lake. Areas of lakes that exhibited trophic gradients or embayment differences often were analyzed separately. Use support in lakes was determined by criteria listed in Table 3.2.1-3.

3.3.5.2 Results

Statewide. Tables 3.3.5.2-1 through 3.3.5.2-9 present statewide summaries of use support, impairments (causes) and sources of impairments of reservoirs, ponds and lakes in the state. The water quality assessment of lakes includes more than 90 percent of the publicly-owned lakes, ponds and reservoirs acreage of Kentucky. Sixty-five of 107 lakes, ponds and reservoirs (61 percent) fully support their uses, and 42 (39 percent) do not support one or more uses. On an acreage basis, approximately 82 percent (538,481 acres) of the 653,120 assessed acres fully support uses, and approximately 18 percent (114,639 acres) do not support one or more uses (Tables 3.3.5-1 – 3).

Methylmercury in fish tissue was the most frequently identified impairment, accounting for the most lake, pond and reservoir acres impacted (Table 3.3.5.2 – 6). Nutrients/eutrophication biological indicators and pH were the second and third most frequent impairments. A list of those sources of impairments is presented in Tables 3.3.5.2-7 – 9. Sources “unknown” were most commonly identified as it relates to impairments affecting Kentucky’s reservoirs and lakes since methylmercury was the primary pollutant;

Table 3.3.5.2-1. Individual use support summary for Kentucky reservoirs.

Use	Total Size	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Not Supporting	Size Not Assessed
Warm Water Aquatic Habitat	218,981	217,810	209,093	0	8,717	1,171
Cold Water Aquatic Habitat	2,410	2,410	2,410	0	0	0
Fish Consumption	218,981	203,031	111,408	0	91,623	15,950
Primary Contact Recreation Water	218,981	2,940	2,940	0	0	216,041
Secondary Contact Recreation Water	218,981	23,441	11,034	0	12,407	195,541
Domestic Water Supply	204,359	202,876	201,215	0	1,661	1,483

Table 3.3.5.2-2. Individual use support summary for Kentucky lakes.

Use	Total Size	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Not Supporting	Size Not Assessed
Warm Water Aquatic Habitat	571	571	378	0	193	0
Fish Consumption	571	36	0	0	36	535
Primary Contact Recreation Water	571	0	0	0	0	571
Secondary Contact Recreation Water	571	0	0	0	0	571

Table 3.3.5.2-3. Individual use support summary for Kentucky ponds.

Use	Total Size	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Not Supporting
Warm Water Aquatic Habitat	4.8	0	0	0	0
Fish Consumption	4.8	4.8	3.3	0	1.5
Primary Contact Recreation Water	4.8	0	0	0	0
Secondary Contact Recreation Water	4.8	0	0	0	0

this pollutant enters aquatic environments from multiple pathways. Agricultural-related sources, along with municipal point sources and septic systems, were the most commonly identified sources related to nutrient impairments (Tables 3.3.5.2-7 and 8). Ponds also had "unknown" as the most common source (Table 3.3.5.2-9) because of methylmercury. A fish consumption advisory for PCBs is in place on one reservoir of considerable size (Green River Lake), resulting in a high percentage of lake acres impacted by priority organics (Table 3.3.5.2-4). Low dissolved oxygen (Table 3.3.5.2-4) was the fourth most common impairment, and a large proportion of this acreage (36 percent) was from one relatively large reservoir (Herrington Lake). A related problem was dissolved gas super-saturation, which often occurs with excess nutrients during daylight hours as photosynthesis from excess algae occurs. Naturally shallow lake or reservoir basins, or those that have excessive sedimentation resulting in shallow basins, often provide suitable habitat for the proliferation of nuisance aquatic weeds that impair secondary contact recreation and account for the fifth highest cause of use nonsupport. Other natural conditions, such as manganese releases from anoxic hypolimnetic water and nutrients in runoff from relatively undisturbed watersheds affect, domestic water supply and secondary contact uses, respectively. Suspended solids from surface mining activities have decreased in severity as a source from previous years but continue to impede full secondary contact recreation use in one eastern Kentucky reservoir.

Trophic state was determined for the number of acres and lakes for the four possible categories of TSI. For this presentation of data, a distinction between lakes (natural waterbodies) and reservoirs (manmade lakes or impoundments) is made. Tables 3.3.5.2-10 and 11 present these results.

Table 3.3.5.2-4. Number of acres of Kentucky reservoirs, lakes and ponds affected by impairments.

Impairment	Total Size
Methylmercury	91,623
Nutrient/Eutrophication Biological Indicators	8,890
pH	8,489
Oxygen, Dissolved	8,234
Polychlorinated biphenyls	8,210
Dissolved Gas Supersaturation	3,864
Total Suspended Solids (TSS)	3,040
Sedimentation/Siltation	2,417
Organic Enrichment (Sewage) Biological Indicators	1,936
Taste and Odor	1,171
Chlorophyll-a	548
Habitat Assessment (Streams)	339
Aquatic Plants (Macrophytes)	331
Manganese	317
Aquatic Algae	169
Impairment Unknown	43

Table 3.3.5.2-5. Number of acres of Kentucky lakes (natural) affected by impairments.

Impairment	Total Size
Nutrient/Eutrophication Biological Indicators	193
Methylmercury	36

Table 3.3.5.2-6. Number of acres of Kentucky ponds affected by impairment.

Impairment	Total Size
Methylmercury	1.5

Table 3.3.5.2-7. Sources of impairments to Kentucky reservoirs.

Source	Total Size
Source Unknown	84,398
Atmospheric Deposition - Toxics	18,638
Upstream Source	11,560
Agriculture	9,087
Industrial Point Source Discharge	8,210
Municipal Point Source Discharges	6,129
On-site Treatment Systems (Septic Systems and Similar Decentralized Systems)	4,232
Livestock (Grazing or Feeding Operations)	3,356
Internal Nutrient Recycling	3,212
Surface Mining	3,040
Natural Sources	2,015
Heap-leach Extraction Mining	1,230
Rural (Residential Areas)	317
Littoral/shore Area Modifications (Non-riverine)	232
Impacts from Abandoned Mine Lands (Inactive)	219
Unspecified Urban Stormwater	170
Non-irrigated Crop Production	169
Crop Production (Crop Land or Dry Land)	137
Grazing in Riparian or Shoreline Zones	99
Habitat Modification - other than Hydromodification	99
Septage Disposal	98
Golf Courses	78
Contaminated Sediments	18

Table 3.3.5.2-8. Sources of impairments to Kentucky lakes (natural).

Source	Total Size
Natural Sources	193
Agriculture	193
Source Unknown	36

Table 3.3.5.2-9. Source of impairment to Kentucky ponds.

Source	Total Size
Source Unknown	1.5

Table 3.3.5.2-10. Trophic state of reservoirs in Kentucky

Trophic State	Number of Lakes	Total Size
Oligotrophic	13	63,686
Mesotrophic	25	17,110
Eutrophic	55	136,481
Hypereutrophic	2	507
Dystrophic	0	0

Table 3.3.5.2-11. Trophic state of lakes in Kentucky

Trophic Status	Number of Lakes	Total Size
Oligotrophic	0	0
Mesotrophic	0	0
Eutrophic	10	501
Hypereutrophic	2	70

Kentucky River Basin Management Unit. Of the fully supporting reservoirs in this BMU, two were eutrophic, three were mesotrophic and one was oligotrophic (Tables 3.3.5.2-12). There were 17 reservoirs monitored or evaluated, six were fully supporting uses and 11 did not support all uses (Table 3.3.5.2-12 – 14). Of reservoirs fully supporting uses, the trend in trophic state was increasing toward a more enriched system as compared to 1998 data (Table 3.3.5.2-12). Dissolved oxygen and nutrient/eutrophication biological indicators were the two most common impairments affecting water quality conditions in these lakes (Tables 3.3.5.2-13 and 14). Excess nutrients (phosphorus and nitrogen) eventually result in depleted or lowered DO in the water column; conversely, the excess algal growth will result in super-saturation of DO during photosynthesis. Sources of those impairments are listed in Tables 3.3.5.2-13 and 14.

Table 3.3.5.2-12. Kentucky River Basin reservoirs that fully support uses.

Lake	Acres	County	Trophic State	Eutrophication Trend	Uses
Bert Combs	36	Clay	Mesotrophic	Increasing	WAH, CAH, SCR, DWS
Corinth	139	Grant	Eutrophic	Increasing	WAH, SCR
General Butler	26	Carroll	Eutrophic	Increasing	WAH, SCR
Fishpond	32	Letcher	Mesotrophic	Increasing	WAH, SCR
Owsley Fork	151.6	Madison	Oligotrophic	Increasing	WAH, SCR, DWS
Mill Creek	41	Wolfe	Mesotrophic	Increasing	WAH, CAH, SCR, DWS

Salt – Licking Basin Management Unit. Of the fully supporting reservoirs in this BMU, eight were eutrophic and six had no data for TSI (five of those six reservoirs were assessed using MORs for drinking water use and one only for fish consumption) (Tables 3.3.5.2-15 and 16). There were 25 reservoirs monitored or evaluated; 14 were fully supporting uses and 11 were not supporting all uses in this BMU during 2004 (Tables 3.3.5.2-15 – 19). Of those, 16 reservoirs were eutrophic, one was mesotrophic and one was hyper-eutrophic (Tables 3.3.5.2-15 – 19). The trends in trophic state of all reservoirs that fully support uses were increasing eutrophy as compared to 1999 data (Tables 3.3.5.2-15 and 16). Methylmercury (fish tissue), nutrient/eutrophication biological indicators, dissolved oxygen and dissolved gas super-saturation were the common impairments listed for those reservoirs not fully supporting (Tables 3.3.5.2-17 – 19). Excess nutrients (phosphorus and nitrogen) eventually result in depleted or lowered DO in the water column; conversely, the excess algal growth will result in super-saturation of DO during photosynthesis. As these reservoirs were primarily in rural areas, sources of these impairments were often related to unknown sources and agriculture (Tables 3.3.5.2-17 – 19).

Table 3.3.5.2-13. Kentucky River Basin reservoirs that partially support uses.

Lake	Acres	County	Trophic State	Use Impaired	Cause of Impairment	Source of Impairment
Boltz	92	Grant	Eutrophic	WAH	Nutrient/Eutrophication Biological Indicators, Dissolved Oxygen	Agriculture, Unspecified Urban Stormwater
Buckhorn	1230	Perry	Mesotrophic	SCR	Siltation, Total Suspended Solids	Agriculture, Natural Sources, Surface Mining, Heap-Leach Extraction Mining
Bullock Pen	134	Grant	Eutrophic	WAH	Nutrient/Eutrophication Biological Indicators, Dissolved Oxygen	Agriculture, Onsite Treatment Systems (and similar decentralized systems)
Carr Creek	710	Knott	Eutrophic	WAH, SCR	Siltation, Nutrient/Eutrophication Biological Indicators, Organic Enrichment (Sewage) Biological Indicators, Dissolved Oxygen, Total Suspended Solids,	Surface Mining, Source Unknown
Cedar Creek	784	Lincoln	Eutrophic	FC	Methylmercury	Source Unknown
Elmer Davis	149	Owen	Eutrophic	WAH	Nutrient/Eutrophication Biological Indicators, Dissolved Oxygen	Agriculture
Herrington	2940	Mercer/ Garrard	Eutrophic	WAH, FC	Nutrient/Eutrophication Biological Indicators, Dissolved Oxygen, Methylmercury	Municipal Point Sources, Internal nutrient recycling , Agriculture, Onsite Treatment Systems (and similar decentralized systems), Source Unknown
Stanford City	43	Lincoln	Mesotrophic	DWS	Taste And Odor, Impairment Unknown	Source Unknown

Table 3.3.5.2-14. Kentucky River Basin reservoirs not supporting uses.

Lake	Acres	County	Trophic State	Use Impaired	Cause of Impairment	Source of Impairment
Pan Bowl	98	Breathitt	Mesotrophic	WAH	Organic Enrichment (Sewage) Biological Indicators, Dissolved Oxygen	Septage disposal, Internal nutrient recycling,
Reba	78	Madison	Eutrophic	WAH	Nutrient/Eutrophication Biological Indicators, Dissolved Oxygen	Golf Courses, Unspecified Urban Runoff
Wilgreen	139	Madison	Eutrophic	WAH, SCR	Nutrient/Eutrophication Biological Indicators, Dissolved Oxygen, Chlorophyll-a, Aquatic Algae	Non-Irrigated Crop Production, Onsite Treatment Systems (and similar decentralized systems), Livestock (grazing and feeding operations)

Table 3.3.5.2-15. Licking River Basin reservoirs that fully support assessed uses.

Lake	Acres	County	Trophic State	Eutrophication Trend	Uses
Greenbriar	66	Montgomery	Eutrophic	Increasing	WAH, SCR, DWS
Williamstown	300	Grant	Eutrophic	Increasing	WAH, SCR, DWS
A. J. Jolly	204	Campbell	Eutrophic	Increasing	WAH, SCR
Carnico	114	Nicholas	Eutrophic	Increasing	WAH, SCR
Evans Branch	22	Rowan	N/A	N/A	DWS
Carlisle Water Supply	8	Nicholas	N/A	N/A	DWS
Flemingsburg	60	Fleming	N/A	N/A	DWS
Doe Valley	372	Meade	N/A	N/A	DWS
Fagan Branch	126	Marion	N/A	N/A	DWS

Table 3.3.5.2-16. Salt River Basin reservoirs that fully support uses.

Lake	Acres	County	Trophic State	Eutrophication Trend	Uses
Sympson	184	Nelson	Eutrophic	Increasing	WAH, SCR, DWS
Marion County	21	Marion	Eutrophic	Increasing	WAH, SCR
Long Run Park	27	Jefferson	Eutrophic	Increasing	WAH, FC, SCR
Willow Pond	3.3	Jefferson	N/A	N/A	FC
Reformatory	54	Oldham	Eutrophic	Increasing	WAH, FC, SCR

Table 3.3.5.2-17. Licking River Basin reservoirs that partially support uses.

Lake	Acres	County	Trophic State	Use Impairment	Cause of Impairment	Source of Impairment
Cave Run	8270	Rowan/Menifee/Bath	Mesotrophic	FC	ph, Methylmercury	Source Unknown, Upstream Source
Kincaid	183	Pendleton	Eutrophic	WAH	Nutrient/Eutrophication Biological Indicators, DO, Dissolved Gas Super-saturation	Agriculture
Doe Run	51	Kenton	Eutrophic	WAH	Nutrient/Eutrophication Biological Indicators, DO, Dissolved Gas Super-saturation	Upstream Source, Source Unknown
Sandlick Creek	74	Fleming	Eutrophic	SCR	Aquatic Macrophytes	Littoral/Shoreline Area Modifications

Table 3.3.5.2-18. Salt River Basin reservoirs partially supporting uses.

Lake	Acres	County	Trophic State	Use Impairment	Cause of Impairment	Source of Impairment
Beaver	158	Anderson	Eutrophic	SCR	Aquatic Macrophytes	Littoral/Shoreline Area Modifications
Chickasaw Park Pond	1.5	Jefferson	N/A	FC	Methylmercury	Source Unknown
McNeely	51	Jefferson	Eutrophic	FC	Methylmercury	Source Unknown
Willisburg	126	Washington	Eutrophic	WAH	Nutrient/Eutrophication Biological Indicators, DO, Dissolved Gas Super-saturation	Upstream Source, Source Unknown
Taylorsville	3050	Anderson/ Nelson/Spencer	Hyper-eutrophic	WAH, FC	Nutrient/Eutrophication Biological Indicators, DO, Methylmercury	Municipal Point Source, Livestock (Grazing & Feeding Operations), Agriculture, Upstream Source, Source Unknown
Jericho	137	Henry	Eutrophic	WAH	Nutrient/Eutrophication Biological Indicators, DO, Dissolved Gas Super-saturation	Agriculture, Crop Production (Crop Land or Dry Land), Livestock (Grazing or Feeding Operations)

Table 3.3.5.2-19. Salt River reservoir not supporting uses.

Lake	Acres	County	Trophic State	Use Impairment	Cause of Impairment	Source of Impairment
Guist Creek	317	Shelby	Hyper-eutrophic	WAH, DWS, FC	Nutrient/Eutrophication Biological Indicators, DO, Dissolved Gas Super-saturation, Methylmercury, Taste and Odor, Manganese	Agriculture, Onsite Treatment Systems (& similar decentralized systems), Rural Residential Areas, Natural Sources, Atmospheric Deposition, Source Unknown